*****Embargoed Until 11AM EST, November 25, 2020*****

The 2020 NASA Space Biology and Aerospace Medicine Paper Highlights & Package Details

By:

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November 15th, 2020

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Contents:

I. Introduction

On November 25th, a coordinated package of 29 scientific papers will be published in five *Cell Press* journals and appear online (https://www.cell.com/c/the-biology-of-spaceflight), including *Cell*, *Cell Reports*, *iScience*, *Cell Systems*, and *Patterns*. These manuscripts span >200 investigators from dozens of academic, government, aerospace, and industry groups, representing the largest set of astronaut data and space biology data ever produced, including longitudinal multi-omic profiling, single-cell immune and epitope mapping, novel radiation countermeasures, and detailed biochemical profiles of 56 astronauts, which represents ~10% of all humans that have ever been in space. The work also cements a unique collaboration across the four largest space agencies: NASA, JAXA, ESA, and ROSCOSMOS.

Below is a summary of the various papers, their highlights, and contact information for the senior authors. There is also a link to web features, online content, and related papers in other journals. Of note, three journals (*Cell*, *Cell Reports*, *iScience*) will feature coordinated cover images that were taken by astronaut Scott Kelly during his year-long mission, as follows:

***Cell* (cover):** "The city lights spanning Japan, glimmering below Earth's thin atmosphere, with the International Space Station and docked Soyuz space capsule." – Photograph by Scott Kelly

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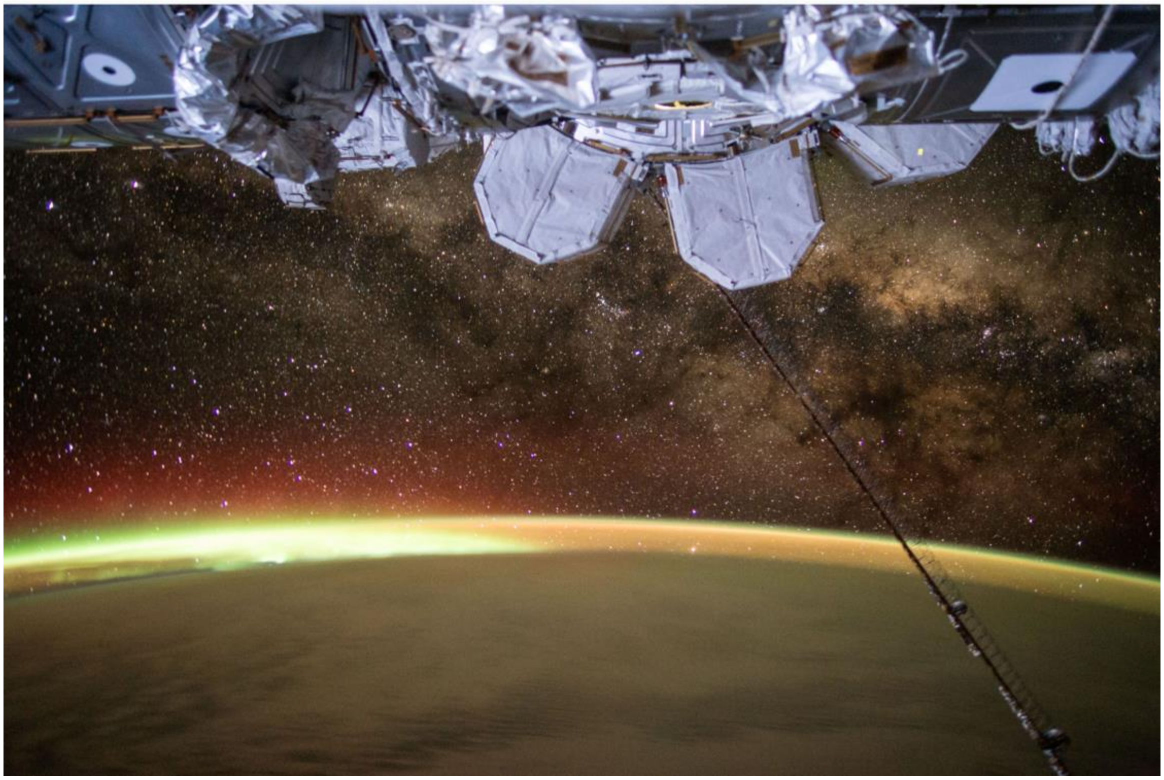
***Cell Reports* (cover):** "Day 142 during the Year-Long Mission of Scott Kelly, with the Aurora Borealis behind the docked Soyuz space capsule." - Photograph by Scott Kelly



***iScience* (cover):** "The Earth's atmosphere below the International Space Station, featuring the Aurora Borealis and the stars." – Photograph by Scott Kelly

II. Papers in *Cell Press* Journals (links active on Nov. 25)

	Title	First Authors	Senior Authors	Journal	Article Type
1	Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep Space Exploration	Ebrahim Afshinnekoo, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute	Susan M. Bailey, Peter Grabham, Sylvain V. Costes, Christopher E. Mason, Afshin Beheshti	*Cell*	Review
2	Comprehensive Multi-Omics Analysis Reveals Mitochondrial Stress as a Central Hub for Spaceflight Biological Impact	Willian A. da Silveira, Hossein Fazelinia, Sara Brin Rosenthal, Evagelia C. Laiakis, Man S Kim, Cem Meydan, Yared Kidane, Komal S. Rathi	Jeffrey S. Willey, Jonathan C. Schisler, Robert Meller, J. Tyson McDonald, Kathleen M. Fisch, Gary Hardiman, Deanne Taylor, Christopher E. Mason, Sylvain V. Costes, Afshin Beheshti	*Cell*	Research Article
3	Multi-omic, Single-cell, and Biochemical Profiles of Astronauts Guide Pharmacological Strategies for Returning to Gravity	Monica Gertz, Christopher Chin	Christopher E. Mason	*Cell Reports*	Research Article
4	Telomere Length Dynamics and DNA Damage Responses Associated with Long-Duration Spaceflight	Jared Luxton	Christopher E. Mason, Susan Bailey	*Cell Reports*	Research Article
5	Circulating miRNA Signature Predicts and Rescues Health Risks Associated with Spaceflight	Sherina Malkani, Christopher R. Chin, Egle Cekanaviciute	Christopher E. Mason, Afshin Beheshti	*Cell Reports*	Research Article
6	Clonal Hematopoiesis Before, During, and After Human Spaceflight	Nuria Trinchant	Duane Hassane, Christopher E. Mason	*Cell Reports*	Research Article
7	Temporal Telomere and DNA Damage Responses in the Space Radiation Environment	Jared Luxton	Christopher E. Mason, Susan Bailey	*Cell Reports*	Research Article
8	Prolonged exposure to microgravity reduces cardiac contractility and initiates remodeling in Drosophila	Stanley Walls	Karen Ocorr	*Cell Reports*	Research Article
9	Advancing the Integration of Biosciences Data Sharing to Further Enable Space Exploration	Scott et al., 2020	Sylvain Costes	*Cell Reports*	Short Preview
10	DNA damage baseline predicts space radiation and radio-therapeutic resilience	Pariset et al., 2020	Sylvain Costes	*Cell Reports*	Research Article
11	A Longitudinal Epigenetic Aging and Leukocyte Analysis of Simulated Space Travel: The Mars-500 Mission	Jamaji Nwanaji-Enwerem	Andres Cardenas	*Cell Reports*	Research Article
12	Cell-free DNA (cfDNA) and exosome profiling from a year-long human spaceflight reveals circulating biomarkers	Daniela Bezdan	Christopher E. Mason	*iScience*	Research Article
13	Comparative transcriptomics identifies altered neuronal and metabolic function as common adaptations to microgravity and hypergravity in Caenorhabditis elegans	Willis et al., 2020	Catherine A. Conley	*iScience*	Research Article
14	Beyond Low Earth Orbit: Characterizing the Immune Profile Following Simulated	Paul et al., 2020	Afshin Beheshti	*iScience*	Research Article

	Spaceflight Conditions for Deep Space Missions				
15	RNAseq analysis of rodent spaceflight experiments: sample collection challenges and confounding factors	Lai Polo et al., 2020	Jonathan Galazka	*iScience*	Methods
16	LET dependent low dose and synergistic inhibition of human angiogenesis by charged particles: Validation of miRNAs that drive inhibition	Wuu et al., 2020	Afshin Beheshti, Peter Grabham	*iScience*	Research Article
17	Dissecting transcriptional responses of Nucleolin mutants to red light stimulation for space farming	Manzano et al., 2020	Raúl Herranz	*iScience*	Research Article
18	Revamping Space-omics in Europe	Madrigal et al., 2020	Raúl Herranz	*Cell Systems*	Short Comm.
19	A New Era for Space Life Science: International Standards for Space Omics Processing (ISSOP)	Lindsay Rutter	Jonathan M. Galazka, Raul Herranz, Masafumi Muratani	*Patterns*	Short Comm.

Papers in review and online (pre-prints or early access):

	Title	First Authors	Senior Authors	Journal	Article Type
20	Telomere length dynamics in response to DNA damage in malaria parasites	Jake Reed	Christopher E. Mason	*iScience*	Short Comm.
21	Haplotype Diversity and Sequence Heterogeneity of Human Telomeres	Kirill Grigorev	Christopher E. Mason	*Genome Research*	Research Article
22	Engineering Radioprotective Human Cells Using the Tardigrade Damage Suppressor Protein, DSUP	Craig Westover	Christopher E. Mason	*Cell Systems*	Research Article
23	Genetic Evidence for Selective Transfer of Microbes Between the ISS and an Astronaut	David Danko	Christopher E. Mason	*Cell Host and Microbe*	Research Article
24	Elevation of Gut-Derived p-Cresol Molecular Networks in Astronauts During Spaceflight Informs Drug Metabolism and Performance	Michael Schmidt	Michael Schmidt, Christopher Mason	*Cell Reports*	Research Article
25	Long Term Cardiovascular Dysfunction Resulting from Galactic Cosmic Ray (GCR) Exposure	Muath Bishawi	Dawn E Bowles	*Cell Reports*	Research Article
26	NASA GeneLab RNA-Seq Consensus Pipeline: Standardized Processing of Short-Read RNA-Seq Data	Eliah Overbey	Sylvain Costes	*Cell Reports*	Review Article
27	Spaceflight Affects Neuronal Morphology and Alters Transcellular Degradation of Neuronal Debris in Adult Caenorhabditis elegans	Ricardo Laranjeiro	Monica Driscoll	*Cell Reports*	Research Article
28	Characterization of Spacesuit Associated Microbial Communities and Implications for Space Missions	David Danko	Christopher E. Mason, Kasthuri J Venkateswaran	*Frontiers*	Research Article
29	Reference-Guided Metagenomics Reveals Genome-Level Evidence of Potential Microbial Transmission from the ISS Environment to an Astronaut's Microbiome	Michael Lee	Michael Lee	*iScience*	Research Article

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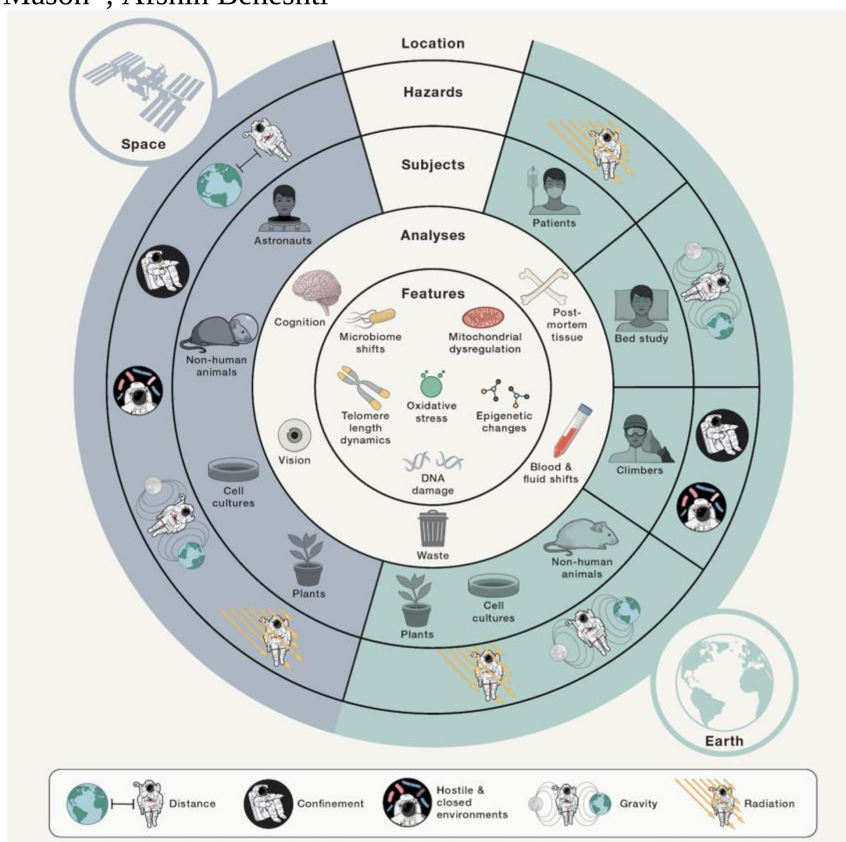
III. Key Papers and Research Highlights

Title: Fundamental Biological Features of Spaceflight: Advancing the Field to Enable Deep Space Exploration

Authors:
Ebrahim Afshinnekoo, Ryan T. Scott, Matthew J. MacKay, Eloise Pariset, Egle Cekanaviciute, Richard Barker, Simon Gilroy, Duane Hassane, Scott M. Smith, Sara R. Zwart, Mayra Nelman-Gonzalez Brian E. Crucian, Sergey A. Ponomarev Oleg I. Orlov Dai Shiba Masafumi Muratani Masayuki Yamamoto, Stephanie E. Richards, Parag A. Vaishampayan, Cem Meydan, Jonathan Foox, Jacqueline Myrrhe, Eric Istasse, Nitin Singh, Kasthuri Venkateswaran, Jessica A. Keune, Hami E. Ray, Mathias Basner, Jack Miller, Martha Hotz Vitaterna, Deanne Taylor, Douglas Wallace, Kathleen Rubins (NASA), Susan M. Bailey*, Peter Grabham*, Sylvain V. Costes*, Christopher E. Mason*, Afshin Beheshti*



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Bailey, Susan susan.Bailey@colostate.edu , Grabham, Peter W. pwg2@cumc.columbia.edu Costes, Sylvain V. sylvain.v.costes@nasa.gov, Mason, Christopher, chm2042@med.cornell.edu, Beheshti, Afshin afshin.beheshti@nasa.gov

Highlights

- Summary of the field to date and the methods to address spaceflight risks and hazards.
- Data resources from all papers in the space biology and aerospace medicine package.
- Hallmarks of space biology seen across model organisms and human data.
- Preparations needed for Mars and missions in the 2020s and 2030s.

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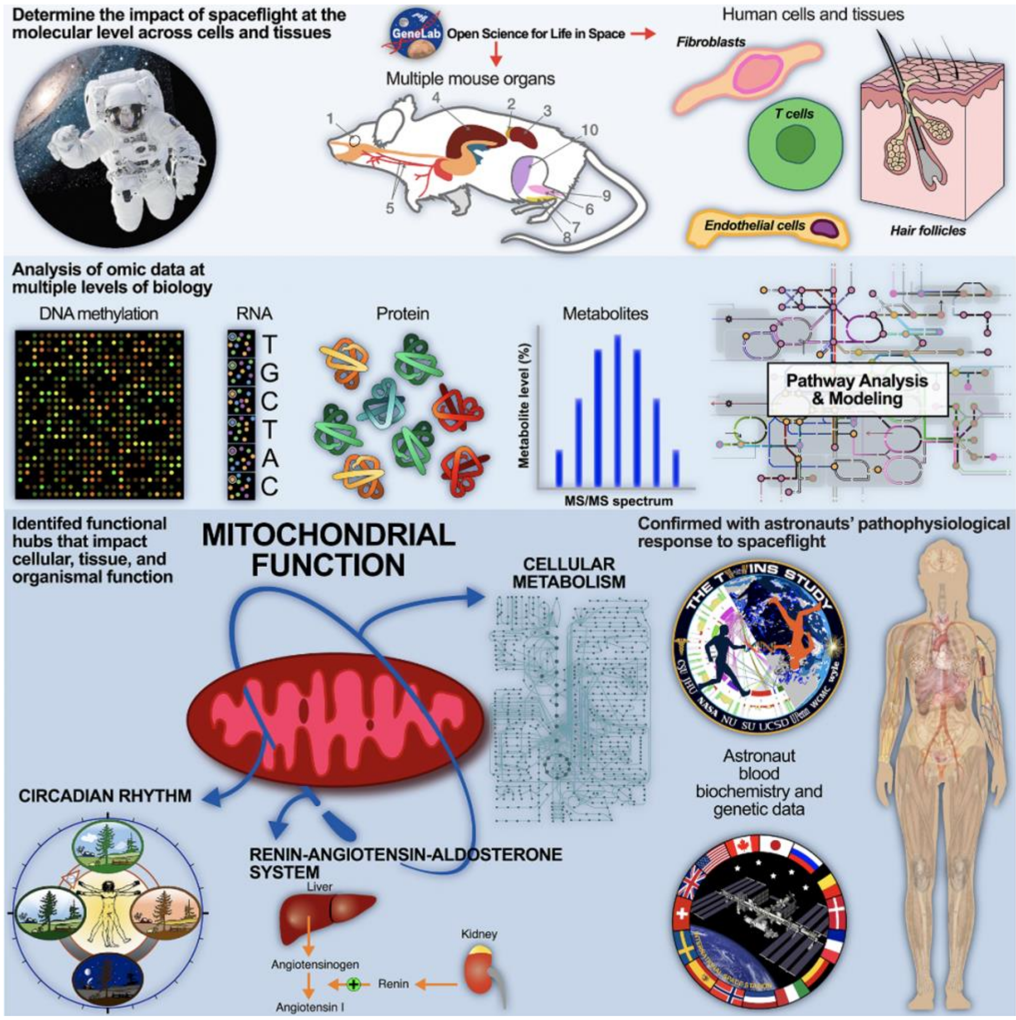
Title: Comprehensive Multi-Omics Analysis Reveals Mitochondrial Stress as a Central Biological Hub for Spaceflight Impact



Authors:

Willian A. da Silveira, Hossein Fazelinia, Sara Brin Rosenthal, Evagelia C. Laiakis, Man S Kim, Cem Meydan, Yared Kidane, Komal S. Rathi, Scott M. Smith, Benjamin Stear, Yue Ying, Yuanchao Zhang, Jonathan Foox, Susana Zanello, Brian Crucian, Dong Wang, Adrienne Nugent, Helio A. Costa, Sara R. Zwart, Sonja Schrepfer, R. A. Leo Elworth, Nicolae Sapoval, Todd Treangen, Matthew MacKay, Nandan S. Gokhale, Stacy M. Horner, Larry N. Singh, Douglas C. Wallace, Jeffrey S. Willey, Jonathan C. Schisler, Robert Meller, J. Tyson McDonald, Kathleen M. Fisch, Gary Hardiman, Deanne Taylor, Christopher E. Mason, Sylvain V. Costes, Afshin Beheshti

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Highlights

- Multi-omics analysis and techniques with NASA's GeneLab platform.
- The largest cohort of astronaut data to date utilized for analysis.
- Mitochondrial dysregulation driving spaceflight health risks.
- NASA Twin Study data validates mitochondrial dysfunction during space missions.

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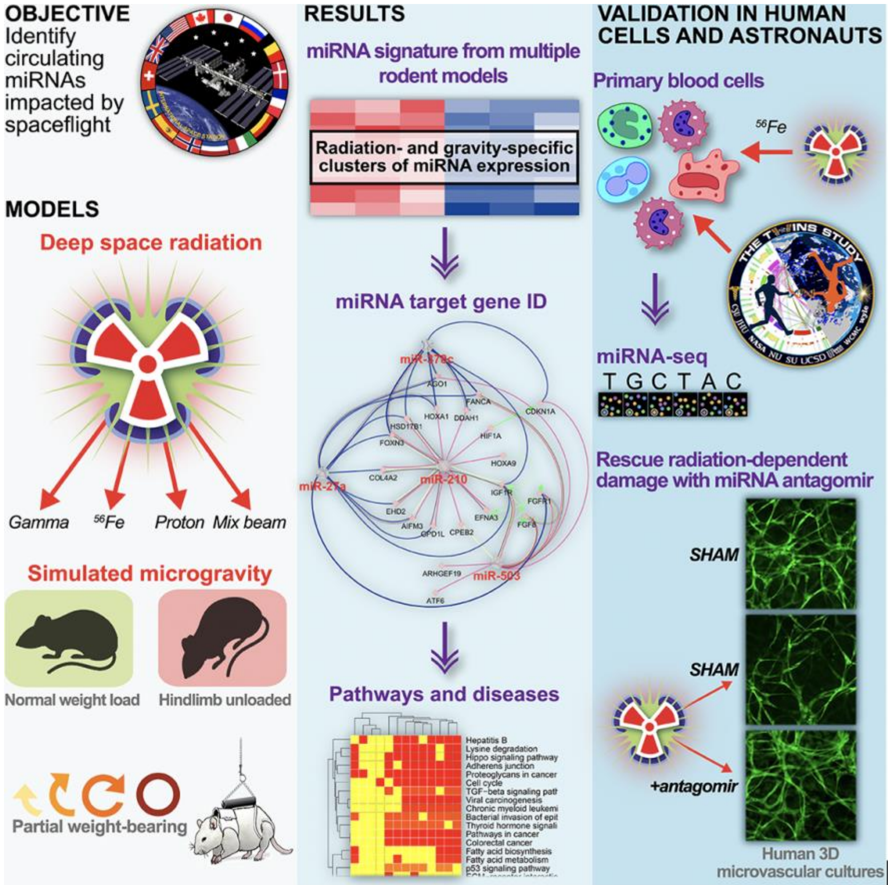
Title: Circulating miRNA Spaceflight Signature Reveals Targets for Countermeasure Development



Authors:

Sherina Malkani, Christopher R. Chin, Egle Cekanaviciute, Marie Mortreux, Hazeem Okinula, Marcel Tarbier, Ann-Sofie Schreurs, Yasaman Shirazi-Fard, Candice G. T. Tahimic, Deyra N. Rodriguez, Brittany S. Sexton, Daniel Butler, Akanksha Verma, Daniela Bezdan, Ceyda Durmaz, Matthew MacKay, Ari Melnick, Cem Meydan, Sheng Li, Francine Garrett-Bakelman, Bastian Fromm, Ebrahim Afshinnekoo, Brad W. Langhorst, Eileen T. Dimalanta, Margareth Cheng-Campbell, Elizabeth Blaber, Jonathan C. Schisler, Charles Vanderburg, Marc R. Friedländer, J. Tyson McDonald, Sylvain V Costes, Seward Rutkove, Peter Grabham, Christopher E. Mason, Afshin Beheshti

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Beheshti, Afshin afshin.beheshti@nasa.gov

Highlights

- First ever spaceflight miRNA signature validated in multiple organism models.
- Components of miRNA signature related to space radiation and microgravity.
- Downstream targets and circulating dependence of miRNAs in NASA Twin Study.
- Inhibition of key microvasculature miRNAs mitigated space radiation impact.

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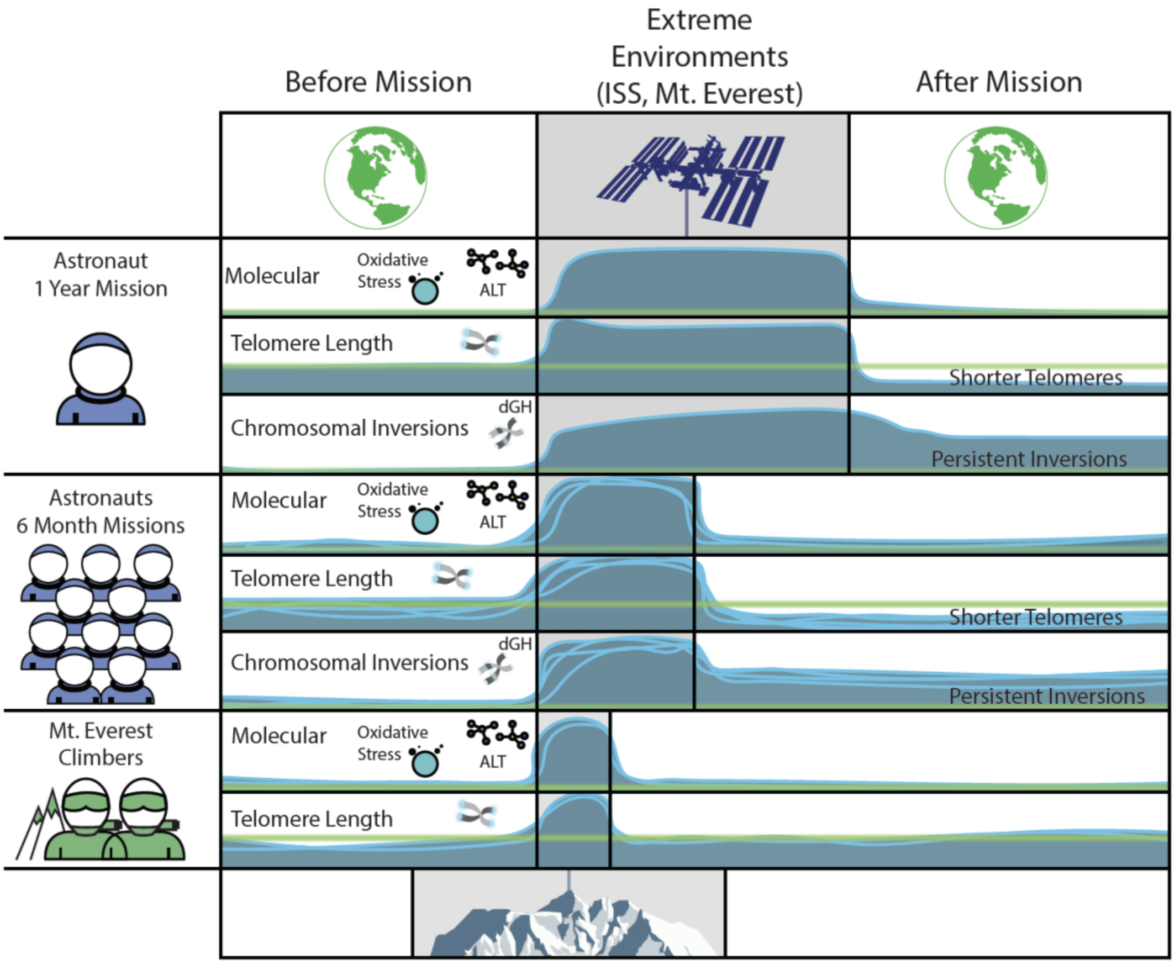
Title: Telomere Length Dynamics and DNA Damage Responses Associated with Long-Duration Spaceflight



Authors:
Jared J. Luxton; Miles J. McKenna; Aidan Lewis; Lynn E. Taylor; Kerry A. George; Sameer M Dixit; Matthew Moniz; Willie Benegas; Matthew J. Mackay; Daniel Butler; Christopher Mozsary; Daniela Bezdan; Cem Meydan; Brian E. Crucian; Sara R. Zwart; Scott M. Smith; Christopher E. Mason; Susan M. Bailey

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Bailey, Susan Susan.Bailey@ColoState.edu

- Astronauts have shorter telomeres than ground controls before and after spaceflight.
- Inter-individual differences were identified in astronaut telomere length after spaceflight.
- Chronic oxidative stress in crewmembers during spaceflight correlates with telomere length dynamics, and also in climbers on Mt. Everest.
- Increased frequencies of chromosomal inversions were observed during and after spaceflight.

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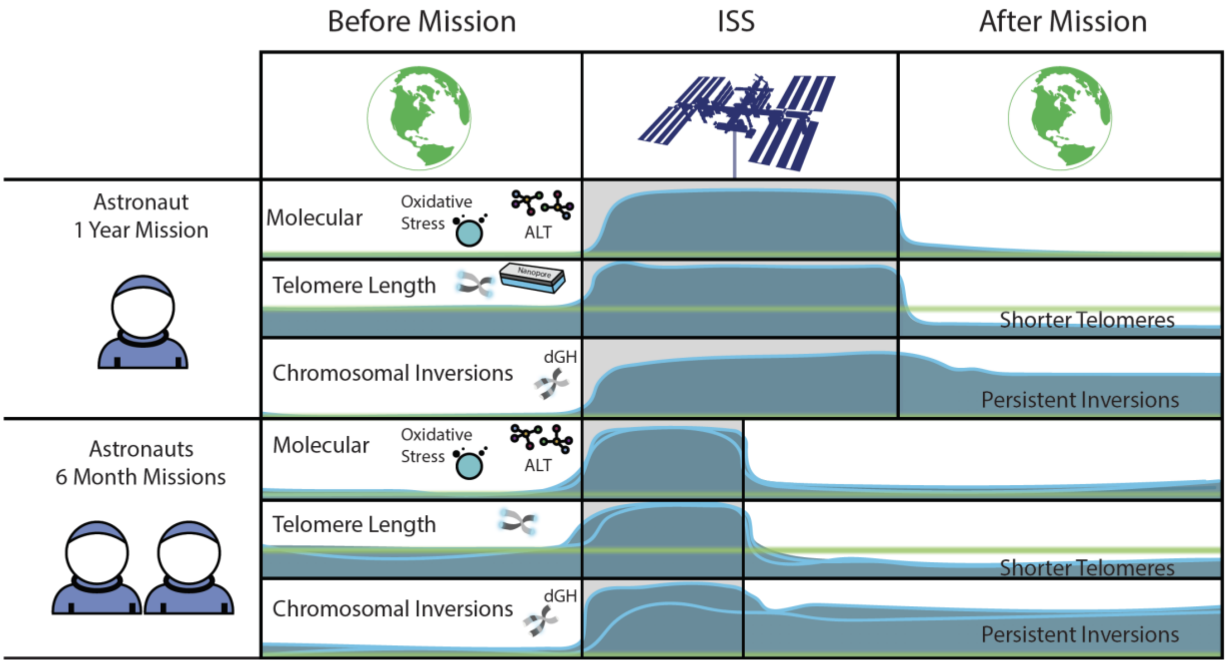
Title: Temporal Telomere and DNA Damage Responses in the Space Radiation Environment



Authors:

Jared J. Luxton, Miles J. McKenna, Lynn E. Taylor, Kerry A. George, Sara R. Zwart, Brian Crucian, Viktor R. Drel, Francine E. Garrett-Bakelman, Matthew J. Mackay, Daniel Butler, Jonathan Foox, Kirill Grigorev, Daniela Bezdan, Cem Meydan, Scott M. Smith, Kumar Sharma, Christopher E. Mason*, and Susan M. Bailey*

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Bailey, Susan Susan.Bailey@ColoState.EDU

Highlights

- Telomere elongation during spaceflight was observed for two six-month mission astronauts
- Telomere elongation was not dependent on mission duration, sample or measurement type (across blood and urine with qPCR, Telo-FISH, Nanopore sequencing).
- Chronic space radiation exposure was associated with persistent DNA damage responses.
- Telomeres shortened rapidly after return to Earth and long-term individual differences were observed.

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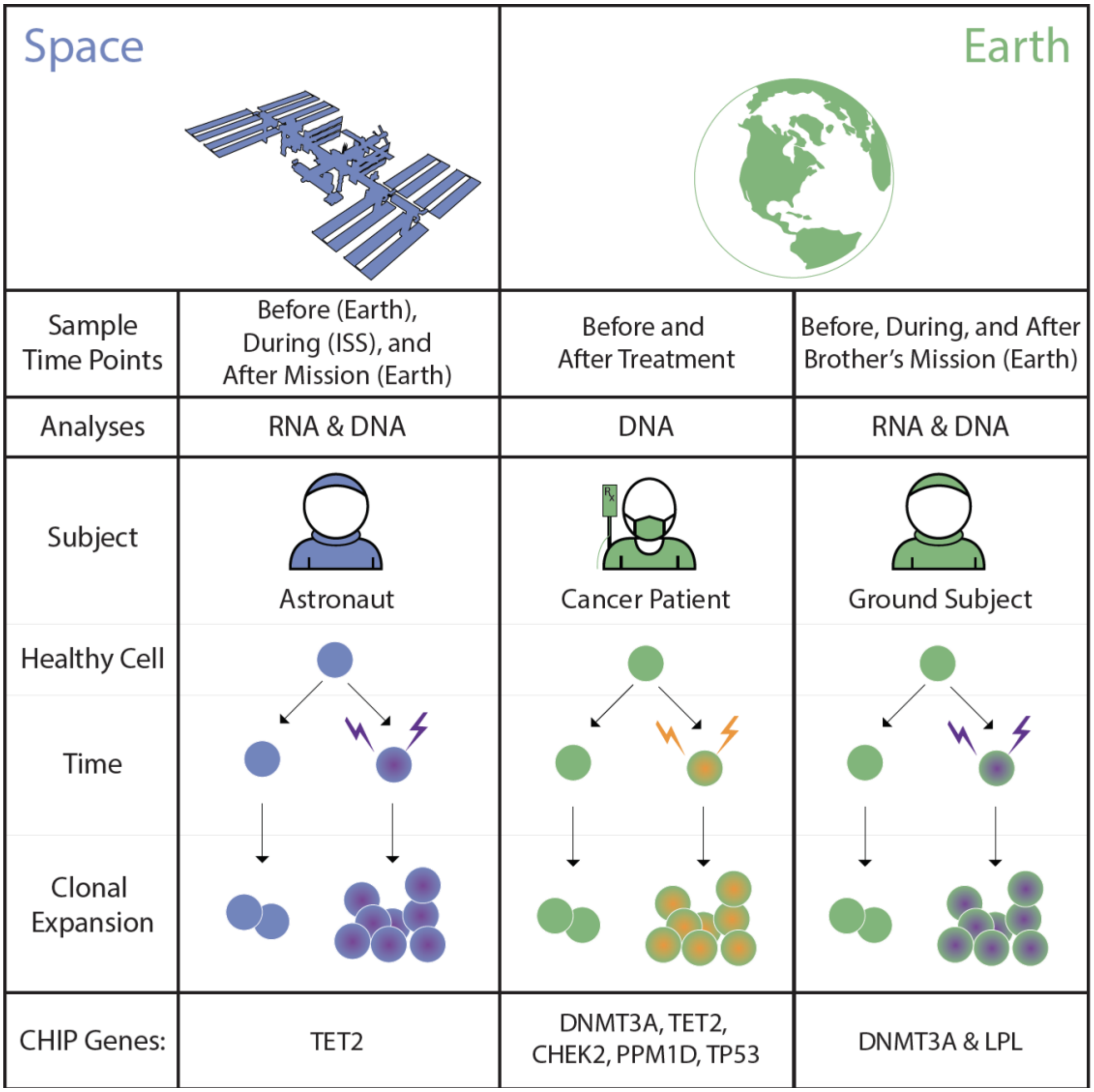
Title: Clonal hematopoiesis before, during, and after human spaceflight



Authors:
Nuria Mencia Trinchant, Matthew J MacKay, Christopher Chin, Ebrahim Afshinnekoo, Jonathan Foox, Cem Meydan, Daniel Butler, Christopher Mozsary, Nicholas A Vernice, Charlotte Darby, Michael C. Schatz, Susan M. Bailey, Ari M. Melnick, Monica Guzman, Kelly Bolton, Lior Z. Braunstein, Francine Garrett-Bakelman, Ross L. Levine, Duane Hassane*, Christopher E. Mason*

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Duane Hassane – duane.hassane@gmail.com
Christopher E. Mason – chm2042@med.cornell.edu

Highlights

- First genome sequence and demonstration of clonal hematopoiesis (CH) in astronauts
- Spaceflight reduced the mutation burden of the CH
- Post-flight CH showed an escalating mutation rate expressed on difference alleles
- Astronauts can show CH about 20 years earlier than expected

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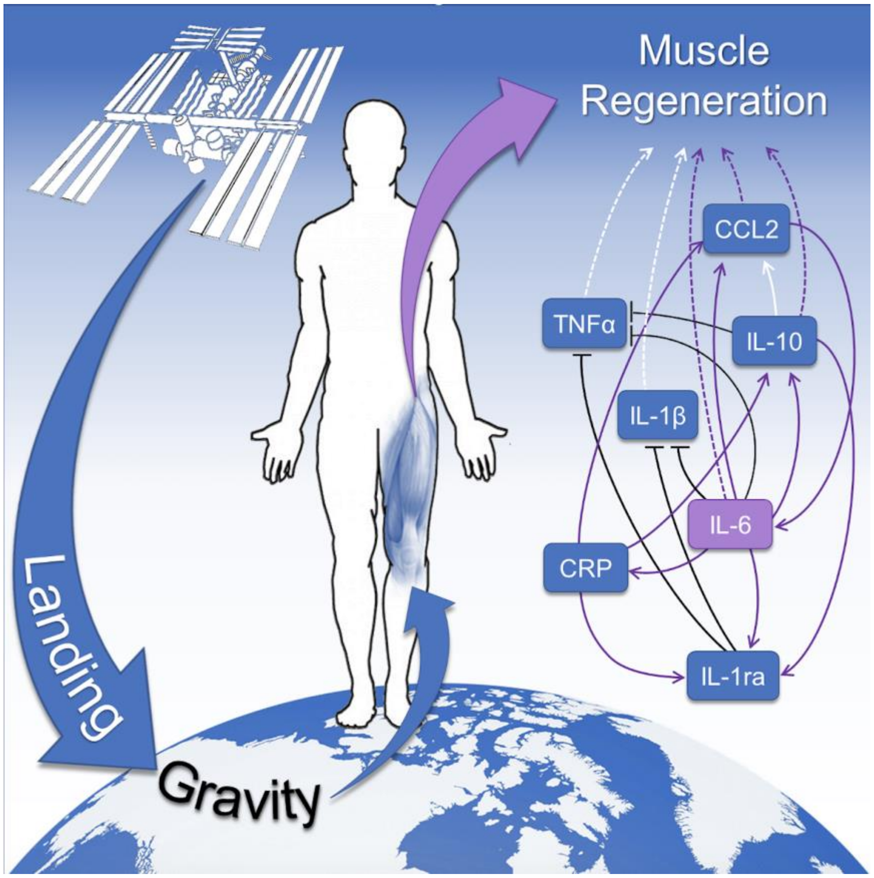
Title: Multi-omic, Single-cell, and Biochemical Profiles of Astronauts Guide Pharmacological Strategies for Returning to Gravity



Authors:
Monica L. Gertz, Christopher R. Chin, Delia Tomoiaga, Matthew J. MacKay, Daniel Butler, Ebrahim Afshinnekoo, Daniela Bezdan, Michael A. Schmidt, Christopher Mozsary, Ari Melnick, Francine Garrett-Bakelman, Brian Crucian, Stuart M.C. Lee, Sara R. Zwart, Scott M. Smith, Cem Meydan, Christopher E. Mason

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Mason, Christopher chm2042@med.cornell.edu

Highlights

- IL-6, IL-10, IL-1ra, CCL2 and CRP rose significantly on landing after a year in space
- IL-6 and IL-ra are potential targets for pharmacological intervention in astronauts
- These cytokines are also associated with muscle regeneration in response to gravity
- Muscle generated IL-6 drives classic signaling cascades in an anti-inflammatory role
- Immune system changes are observed in single-cell chromatin, expression, and epitope data (scRNA-seq, scATAC-seq, sc-Abseq)

*****Embargoed Until 11AM EST, November 25, 2020*****

Cell-free DNA (cfDNA) and exosome profiling from a year-long human spaceflight reveals circulating biomarkers

Authors: *Daniela Bezdan, Kirill Grigorev, Cem Meydan, Fanny A. Pelissier Vatter, Michele Cioffi, Varsha Rao, Kiichi Nakahira, Philip Burnham, Ebrahim Afshinnekoo, Craig Westover, Daniel Butler, Christopher Mozsary, Matthew MacKay, Jonathan Foox, Tejaswini Mishra, Serena Lucotti, Brinda K. Rana, Ari M. Melnick, Haiying Zhang, Irina Matei, David Kelsen, Kenneth Yu, David C Lyden, Lynn Taylor, Susan M Bailey, Michael P.Snyder, Francine E. Garrett-Bakelman, Stephan Ossowski, Iwijn De Vlaminck, Christopher E. Mason*

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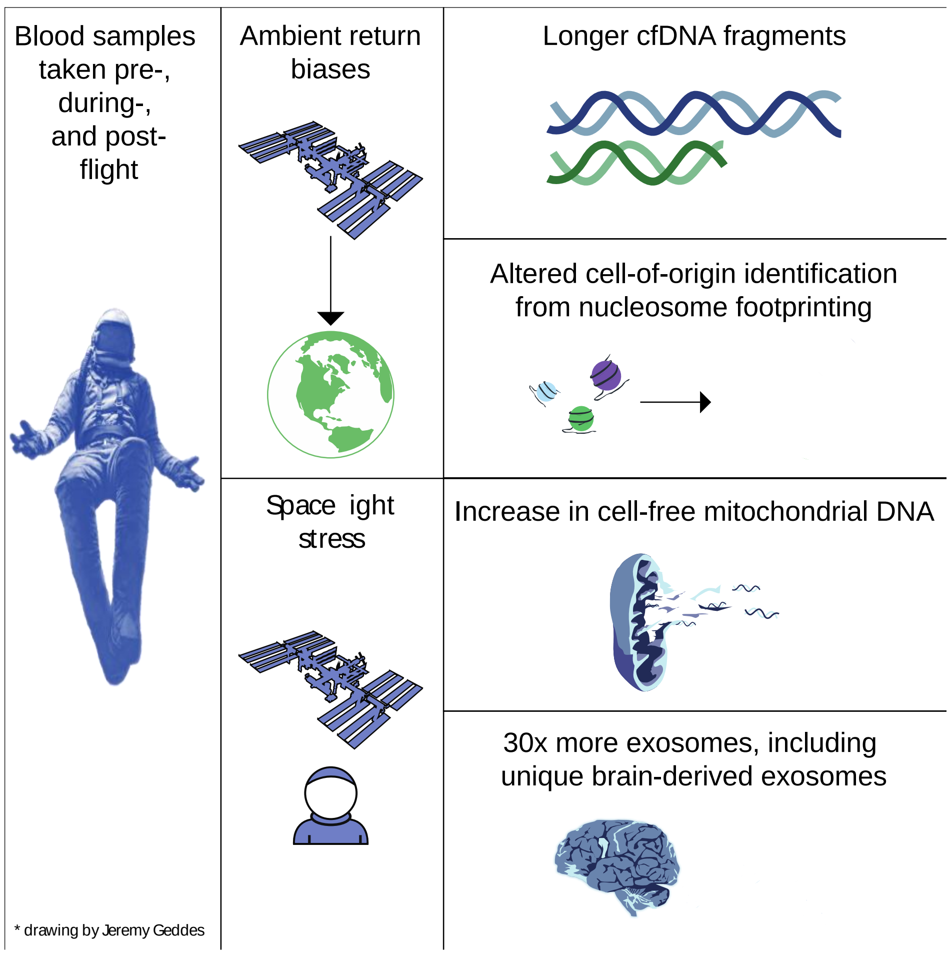

Highlights

- Liquid biopsy can monitor the health conditions of astronauts during spaceflight.
- A significant increase in cell-free mitochondrial DNA during spaceflight
- A 30x increase in circulating exosome levels post-flight and brain-derived proteins.
- Controls for sampling from the ISS can correct for technical noise.

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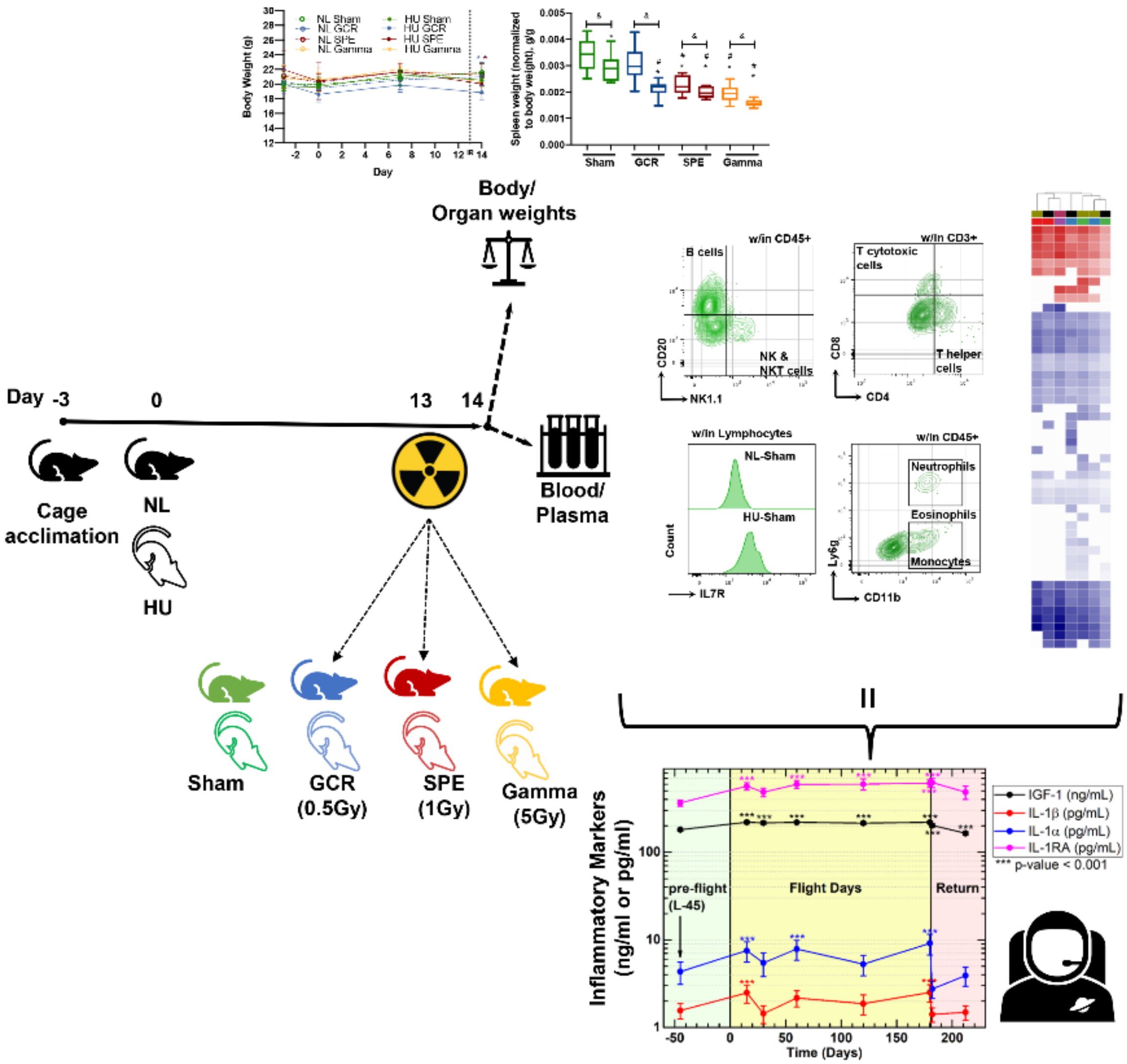
Title: Beyond Low-Earth Orbit: Characterizing Immune and microRNA Differentials Following Simulated Deep Spaceflight Conditions in Mice



Authors:

Amber M. Paul, Margareth Cheng-Campbell, Elizabeth A. Blaber, Sulekha Anand, Sharmila Bhattacharya, Sara R. Zwart, Brian E. Crucian, Scott M. Smith, Robert Meller, Peter Grabham and Afshin Beheshti

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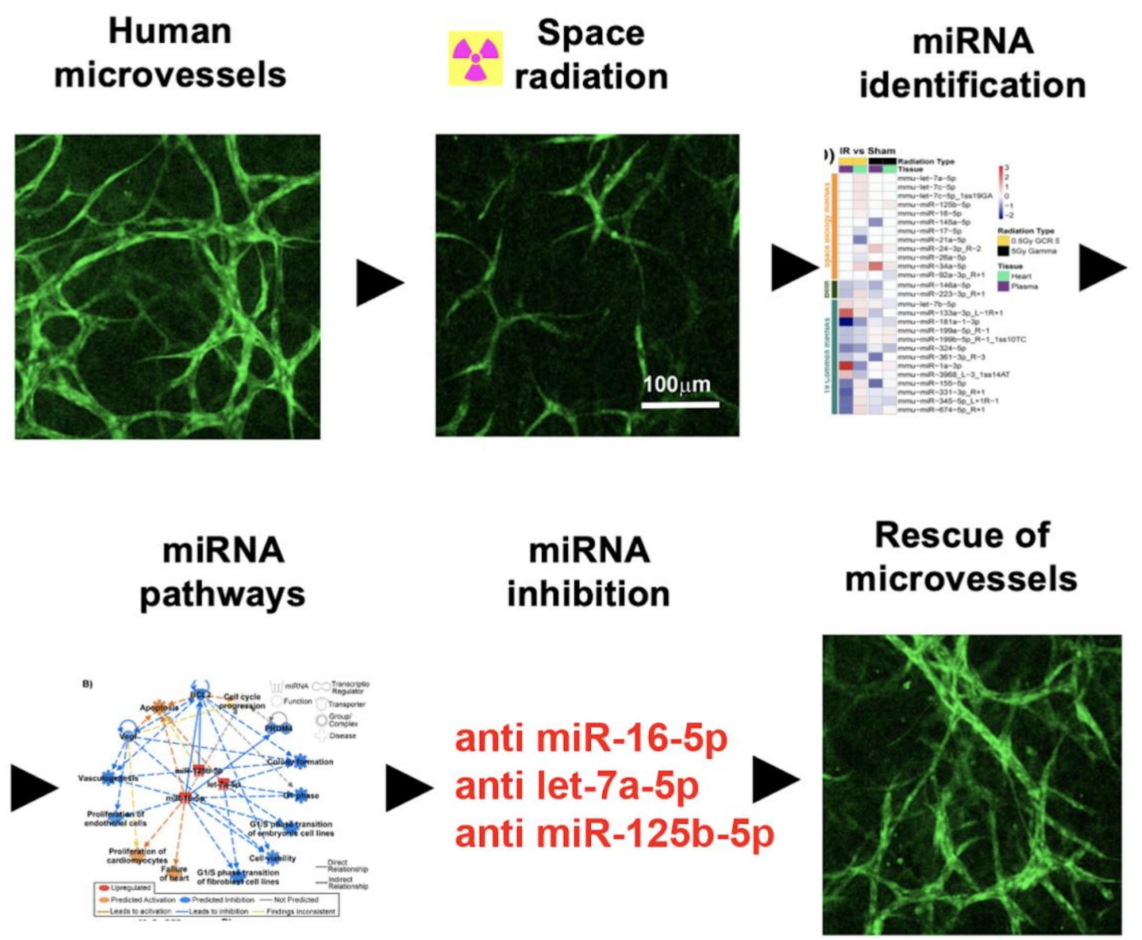
Highlights

- Murine immune profiles from simulated deep spaceflight conditions were analyzed.
- Immune profiling revealed unique immune diversity with each experimental condition.
- Plasma microRNA sequence analysis revealed involvment in immune system dysregulation.
- Astronaut data showed elevated inflammation during low-Earth orbit missions.

Embargoed Until 11AM EST, November 25, 2020

Title: LET dependent low dose and synergistic inhibition of human angiogenesis by charged particles: Validation of microRNAs that drive inhibition.



Authors:
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Highlights

- Space radiation inhibits angiogenesis synergistically at low doses by two distinct mechanisms.
- Candidates for bystander transmission are microRNAs.
- Analysis of three previously identified miRNAs showed downregulation of their angiogenesis targets.
- Synthetic miRNA inhibitors were successfully used to reverse the inhibition of angiogenesis.

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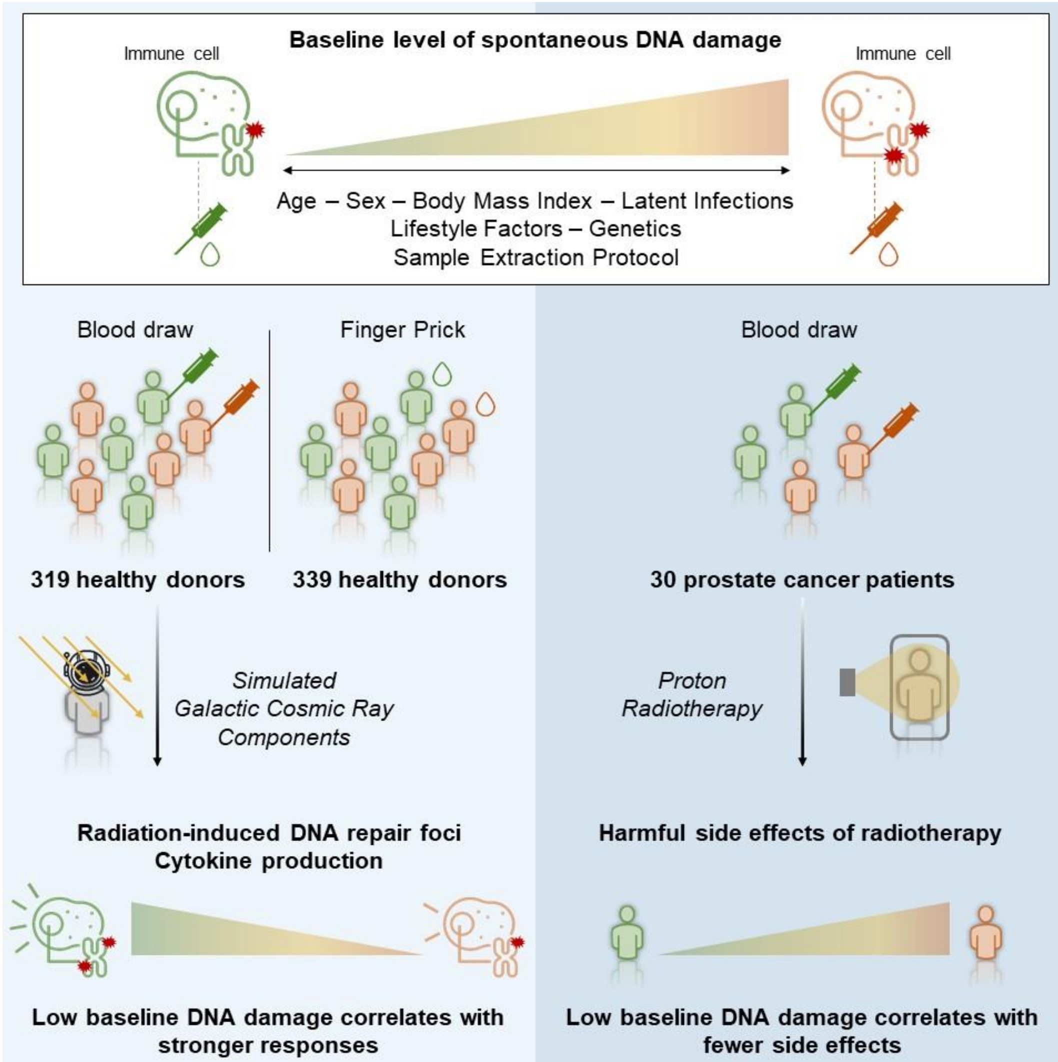
Title: DNA damage baseline predicts resilience to space radiation and radio-therapy



Authors:
Eloise Pariset, Antonella Bertucci, Margaux Petay, Sherina Malkani, Alejandra Lopez Macha, Ivan G. Paulino Lima, Vanesa Gomez Gonzalez, Antony S. Tin, Jonathan Tang, Ianik Plante, Egle Cekanaviciute, Marcelo Vazquez, and Sylvain V. Costes

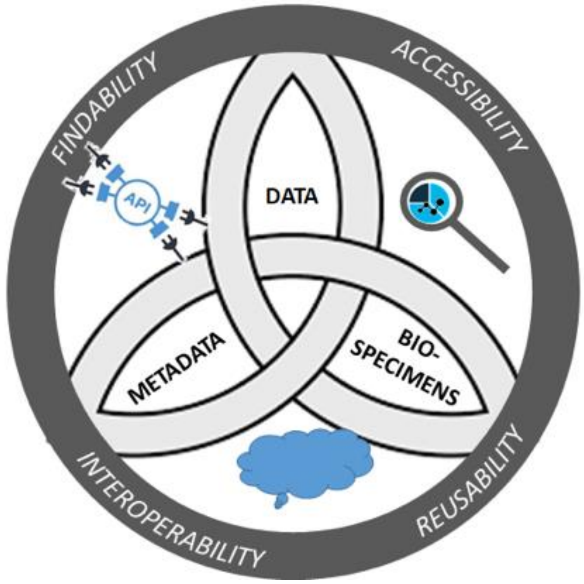
Contacts:
Sylvain V. Costes sylvain.v.costes@nasa.gov

Highlights

- Baseline DNA damage in human immune cells correlates with age and latent infection
- Low baseline DNA damage results in better clinical outcomes after radiotherapy
- Low baseline DNA damage correlates with stronger DNA repair response to irradiation
- Low baseline DNA damage correlates with higher inflammatory cytokine dose response

Embargoed Until 11AM EST, November 25, 2020

Title: Advancing the Integration of Biosciences Data Sharing to Further Enable Space Exploration



Authors:
Ryan T. Scott, Kirill Grigorev, Graham Mackintosh, Samrawit G. Gebre, Christopher E. Mason, Martha E. Del Alto, Sylvain V. Costes

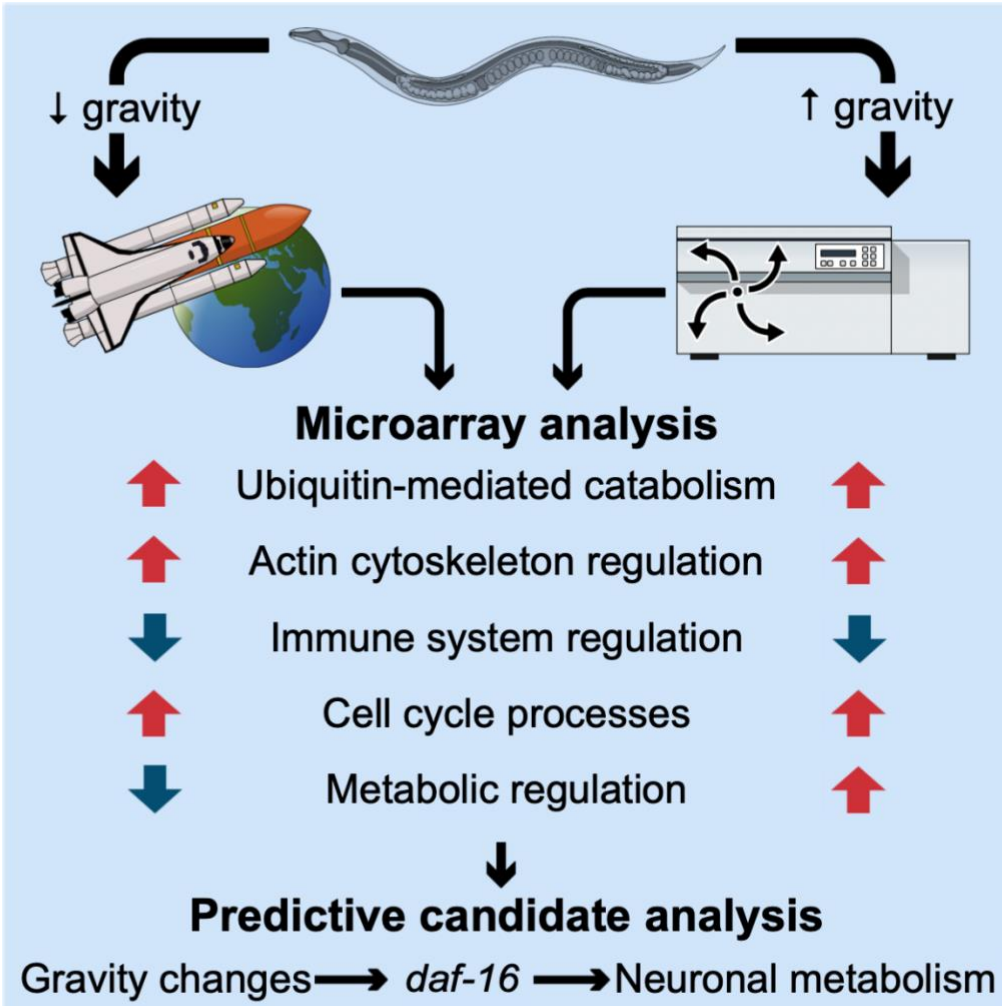
Corresponding Author:
Sylvain V. Costes sylvain.v.costes@nasa.gov

Highlights:

- NASA non-omics and non-human biospecimens are available through the Ames Life Sciences Data Archive (ALSDA) and space-relevant omics data across model organisms are available in GeneLab.
- Data integration between GeneLab and ALSDA furthers the ability to utilize technologies such as artificial intelligence (AI) and machine learning (ML) methodologies to develop new hypotheses.
- Database standards and accessibility such as FAIR principles and APIs enables open-access science promoting collaborative efforts to interpret spaceflight effects by integrating omics and physiological data to the systems level.

Embargoed Until 11AM EST, November 25, 2020

Title: Comparative transcriptomics identifies neuronal and metabolic adaptations to hypergravity and microgravity in Caenorhabditis elegans



Authors: Craig R. G. Willis, Nathaniel J. Szewczyk, Sylvain V. Costes, Ingrid A. Udranszky, Sigrid S. Reinsch, Timothy Etheridge, Catharine A. Conley

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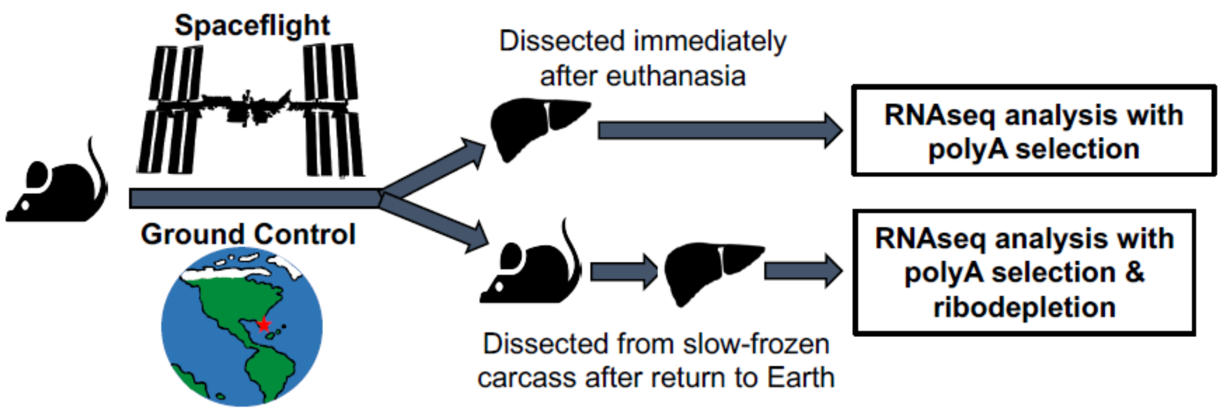
Timothy Etheridge t.etheridge@exeter.ac.uk.

Highlights:

- Comparative transcriptomics in C. elegans exposed to hypergravity and spaceflight.
- Bioinformatics identifies novel putative regulators of altered gravitational load.
- Candidate molecules infer a close gravity>daf-16/FOXO>neuronal link.

*****Embargoed Until 11AM EST, November 25, 2020*****

Title: RNAseq analysis of rodent spaceflight experiments is confounded by sample collection techniques



Authors:
San-Huei Lai Polo, Amanda Saravia-Butler, Valery Boyko, Marie T. Dihn, Yi-Chen chen, Homer Fogle, Sigrid S. Reinsch, Shayoni Ray, Kaushik Chakravarty, Oana Marcu, Rick B. Chen, Sylvain V. Costes, Jonathan M. Galazka

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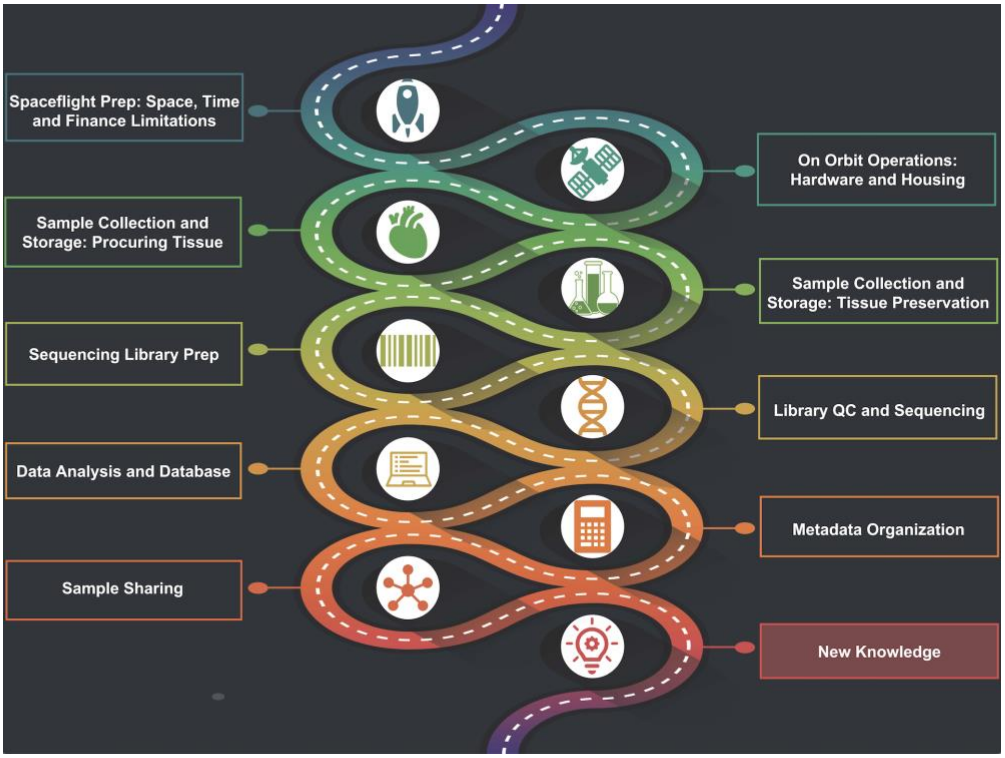
Highlights:

- Preservation method is the primary driver of gene expression variance in RR-1 liver samples.
- Expression of genes involved in 5'-methylguanosine decapping and polyA removal is affected by preservation condition.
- Samples sequenced following ribodepletion exhibit more uniform transcript coverage than samples prepared with polyA selection.
- Total RNA sequencing mitigates the impact of preservation method on gene expression changes in the liver.

*****Embargoed Until 11AM EST, November 25, 2020*****

Title: A New Era for Space Life Science: International Standards for Space Omics Processing (ISSOP) (https://biorxiv.org/cgi/content/short/2020.11.06.371724v1)



Authors:
Lindsay Rutter, Richard Barker, Daniela Bezdan, Henry Cope, Sylvain V. Costes, Lovorka Degoricija, Kathleen M. Fisch, Mariano I. Gabitto, Samrawit Gebre, Stefania Giacomello, Simon Gilroy, Stefan J. Green, Christopher E. Mason, Sigrid S. Reinsch, Nathaniel J. Szewczyk, Deanne M. Taylor, Jonathan M. Galazka, Raul Herranz, Masafumi Muratani

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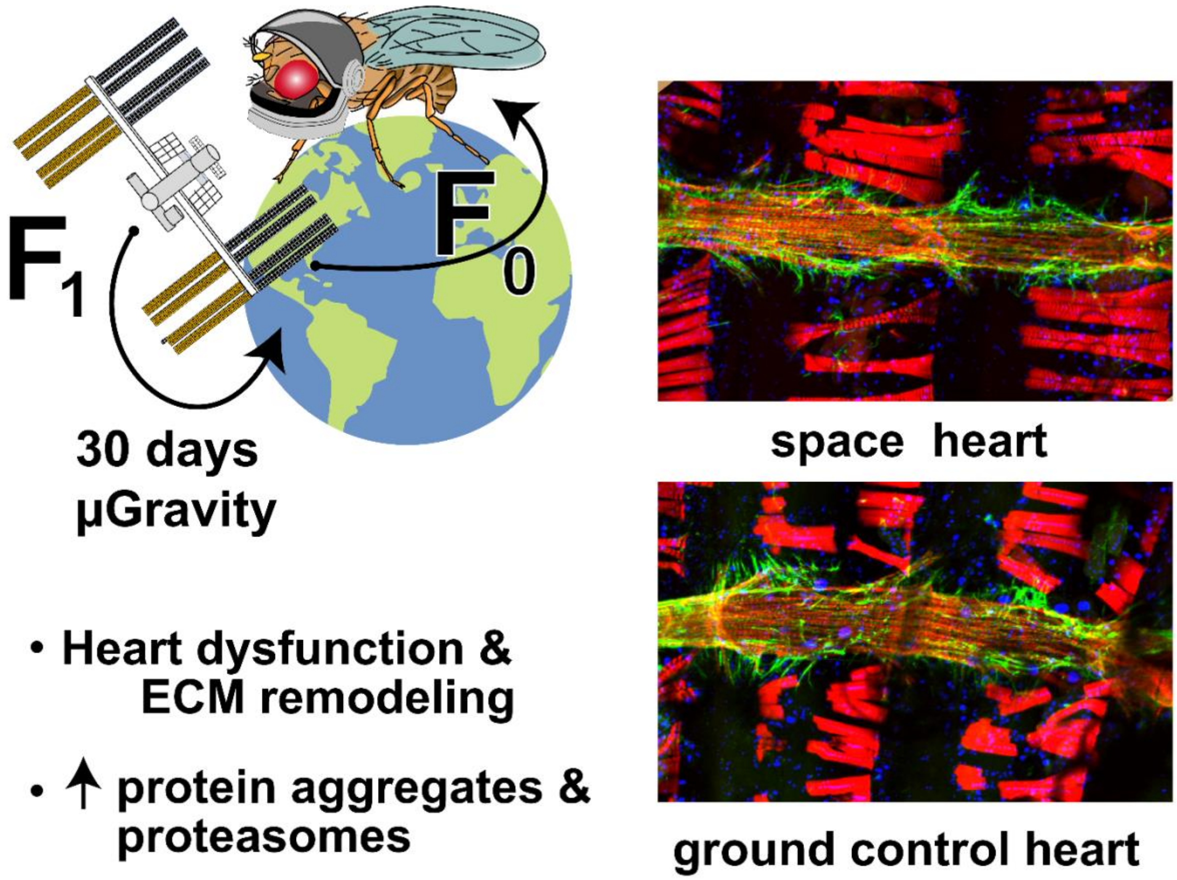
Raúl Herranz rherranz@cib.csic.es
Masafumi Muratani muratani@md.tsukuba.ac.jp

Highlights:
- ISSOP is an international consortium of scientists who recognizes the growing need for sample processing standardization and metadata normalization of space omics studies at the global level.
- Optimizing the conditions for scientists and the general public to derive valid hypotheses from these precious space omics data by reducing confounding factors and increasing interoperability at the global level.
- Introductory reference for students and new members in the space omics and the larger space biology discipline.
- Using standardization efforts to understand the effects of spaceflight on biological organisms and preparing the international community toward developing safe and effective crewed space exploration beyond low earth orbit.

*****Embargoed Until 11AM EST, November 25, 2020*****

Title: Prolonged exposure to microgravity reduces cardiac contractility and initiates remodeling in *Drosophila*.



Authors:
Stanley Walls, Soda Diop, Ryan Birse, Lisa Elmen, Zhuohui Gan, Sreehari Kalvajuri, Curran Reddy, Erika Taylor, BoscoTrinh, George Vogler, Rachel Zarndt, Andrew McCulloch, Peter Lee, Sharmila Bhattacharya, Rolf Bodmer, Karen Ocorr

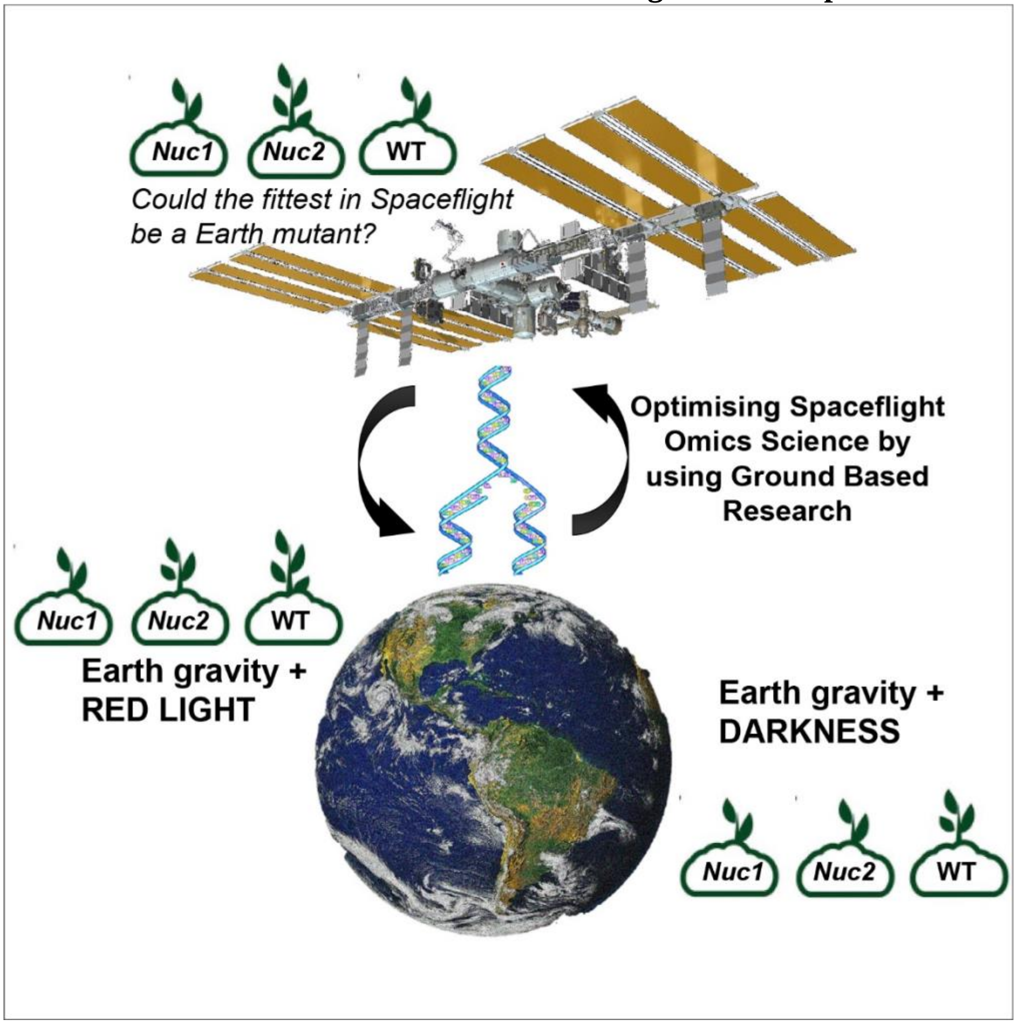
Contacts:
Rolf Bodmer rolf@sbpdiscovery.org,
Karen Ocorr kocorr@sbpdiscovery.org

Highlights:

- Flies in microgravity exhibit cardiac constriction, remodeling and diminished output
- Heart defects correlate with reduced sarcomeric/ extracellular matrix gene expression
- Proteasome gene/protein expression is upregulated suggesting proteostasis imbalance

Embargoed Until 11AM EST, November 25, 2020

Title: The Importance of Earth Reference Controls in Spaceflight -Omics Research: Characterization of Nucleolin Mutants from the Seedling Growth Experiments



Authors:
Aranzazu Manzano, Alicia Villacampa, Julio Saez-Vasquez, John Z. Kiss, F. Javier Medina, Raul Herranz

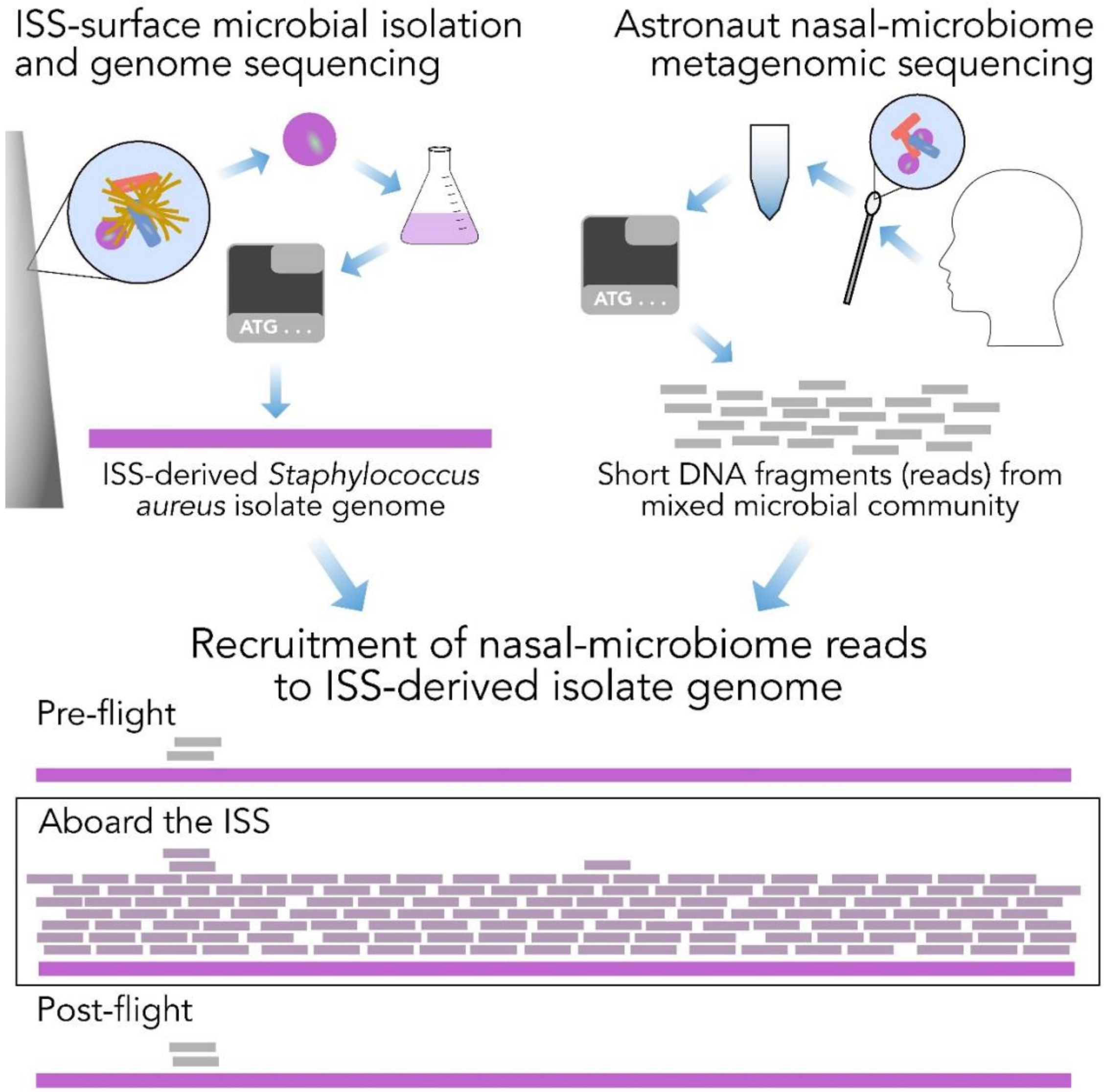
Contact:
Raúl Herranz rherranz@cib.csic.es

Highlights

- Ribosome synthesis is a target of spaceflight stressor effects on plant development
- Nucleolin mutants promote a differential response to light/darkness stress.
- Red light and NUC2 may counteract the spaceflight alterations in gene expression
- Interpretation of Spaceflight –omics experiments relies on ground controls.

Embargoed Until 11AM EST, November 25, 2020

Title: Reference-guided metagenomics reveals genome-level evidence of potential microbial transmission from the ISS environment to an astronaut's microbiome



Authors:
Michael D. Lee, Aubrie O'Rourke, Hernan Lorenzi, Brad M. Bebout, Chris L. Dupont, and R. Craig Everroad

Contact: Michael Lee Mike.Lee@nasa.gov

Highlights:

- Having an understanding of the microbiomes of built-environments and how they interact with the people living and working in those environments is especially critical for spacecraft such as the International Space Station (ISS).
- Integration of ISS-derived microbial isolate genomes with metagenomic data from astronaut nasal microbiomes captures at the whole-genome level likely microbial colonization while aboard the ISS.

Embargoed Until 11AM EST, November 25, 2020

Title: Revamping Space-omics in Europe

Authors:
Pedro Madrigal, Alexander Gabel, Alicia Villacampa, Aranzazu Manzano, Colleen S. Deane, Daniela Bezdan, Eugénie Carnero-Diaz, F. Javier Medina, Gary Hardiman, Ivo Grosse, Nathaniel Szewczyk, Silvio Weging, Stefania Giacomello, Stephen Harridge, Tessa Morris-Paterson, Thomas Cahill, Willian A. da Silveira, Raúl Herranz*

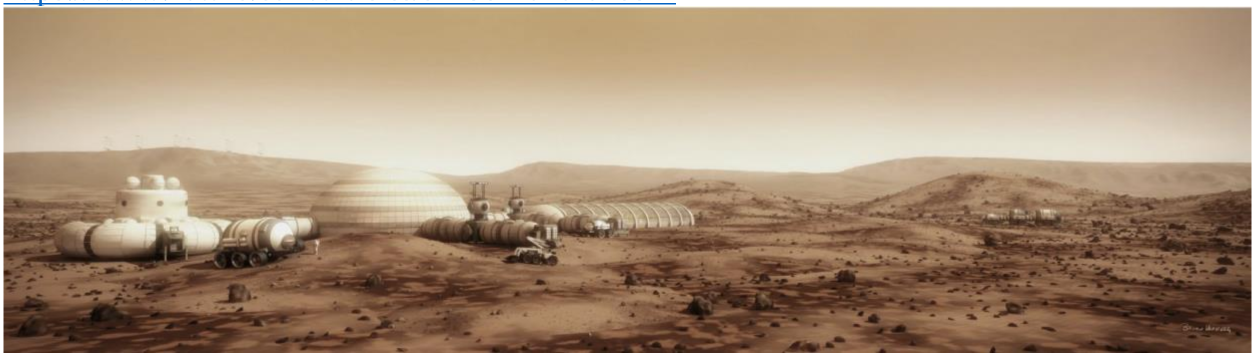
Contact:
Raúl Herranz rherranz@cib.csic.es

Highlights

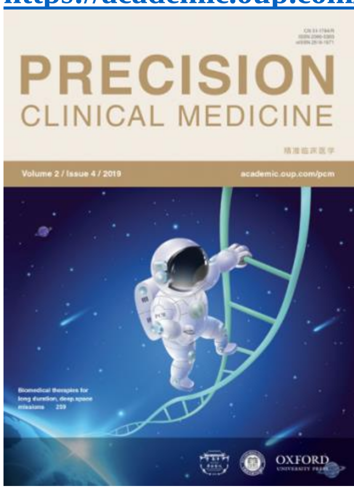
- Space science has generated >300 omics datasets, many planned and executed by European scientists.
- ESA Member State scientists participate in NASA GeneLab AWGs, and co-chair two of them.
- SpaceOmics TT is funded by ESA to ease European contributions to NASA GeneLab and ISSOP initiatives.
- SpaceOmics TT boosts international synergies for space biology at ESA Member States.

IV. Links to other journals/papers/covers on the Twins and related NASA data:

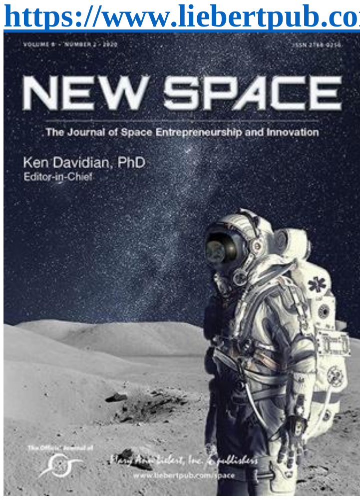
The case for biotech on Mars
https://www.nature.com/articles/s41587-020-0485-4



Translating current biomedical therapies for long duration, deep space missions
https://academic.oup.com/pcm/advance-article/doi/10.1093/pcmedi/pbaa022/5858004



Why Personalized Medicine Is the Frontier of Medicine and Performance for Humans in Space
https://www.liebertpub.com/doi/full/10.1089/space.2019.0037



V. Space Biology online links and resources

GeneLab: a comprehensive space-related omics database; users can upload, download, share, store, and analyze spaceflight and spaceflight-relevant data from experiments using model organisms.
Home Page: **https://genelab.nasa.gov/**
Data Repository: https://genelab-data.ndc.nasa.gov/genelab/projects
API: https://genelab.nasa.gov/genelabAPIs
Analysis Platform: https://galaxy.genelab.nasa.gov/

NASA Twins Study: https://www.nasa.gov/twins-study/
This features previous work on the first set of data from 2019 that was published last year by NASA and Science. This includes data portals, explanatory videos, and interactive features for the study.

NASA Lifetime Surveillance of Astronaut Health (LSAH): LSAH is a proactive occupational surveillance program for the astronaut corps to screen and monitor astronauts for occupational related injury or disease. The LSAH program examines the incidence of acute and chronic morbidity and mortality of astronauts, and defines health risks associated with the occupational exposures encountered by astronauts. From the evidence obtained through clinical testing, individually tailored follow-up medical examinations and surveillance for particular outcomes will be designed to track the astronaut population more rigorously and to capture sub-clinical medical events.
https://lsda.jsc.nasa.gov/lsah/LSAH_Home

NASA Life Sciences Data Archive (LSDA): The NASA Life Sciences Data Archive (LSDA) is the primary source of life sciences research data and information from decades of spaceflight and ground-analog research involving human, microbe, plant, and animal subjects. Data is collected from NASA-funded investigations through the Human Research Program and the Space Biology Program.
Home Page: https://lsda.jsc.nasa.gov
Sample Request Page: https://lsda.jsc.nasa.gov/Request/dataRequestFAQ

NASA Human Research Roadmap: Crew health and performance is critical to successful human exploration beyond low Earth orbit. The Human Research Program (HRP) investigates and mitigates the highest risks to human health and performance, providing essential countermeasures and technologies for human space exploration. Risks include physiological and performance effects from hazards such as radiation, altered gravity, and hostile environments, as well as unique challenges in medical support, human factors, and behavioral health support. The HRP utilizes an Integrated Research Plan (IRP) to identify the approach and research activities planned to address these risks, which are assigned to specific Elements within the program. The Human Research Roadmap (HRR) is the web-based tool for communicating the IRP content, Evidence Reports, external reviews of HRP research, and general HRP organizational information. Home Page: https://humanresearchroadmap.nasa.gov/

NASA Astrobiology Habitable Environments Database (AHED): Astrobiology is an inherently multidisciplinary field. Effective, high impact research requires the integration of disparate sets of data that often extend beyond traditional scientific disciplines, the expertise of a single team member, or even a team of scientists. However, tools for data sharing and data integration within astrobiology (and other disciplines) remain in their infancy. With increasing capacity to acquire new data, resulting from technological advances in instrumentation, and federal mandates to share and archive data, there is a clear need in the broader research community for a high quality, central astrobiology data repository and analysis platform.
Home Page: https://www.nasa.gov/ames/ahed

Non-human biorepository of the Institutional Scientific Collection at Ames Research Center (ISC-ARC): A biorepository collection of non-human spaceflight biological samples exists at NASA's Ames Research Center. The samples are predominantly from rodent studies but also includes quail tissues and samples of microbes. The Ames Life Sciences Data Archive manages this biorepository, part of the NASA Institutional Scientific Collection at Ames Research Center (ISC-ARC). The largest of its kind, only a handful of such repositories exist anywhere on Earth. Dating back to 1979, the NASA ISC-ARC stores about 32,000 non-human biospecimens. Although mostly obtained from International Space Station and Space Shuttle flight investigations, the collection also includes samples brought back to Earth from Russian COSMOS flights and from spaceflight analog studies. NASA provides an opportunity to generate new scientific knowledge from these previously flown spaceflight experiments by sharing biospecimens with the scientific community through an open-science approach. These biospecimens have been requested, awarded, and analyzed by researchers using a wide range of techniques, including microscopy, histology, and a number of molecular analyses collectively known as "omics." The biospecimens are searchable through the LSDA Biospecimen Portal, with a flyer showing a summary of samples available for request.
Home Page: https://www.nasa.gov/ames/research/space-biosciences/isc-bsp

JAXA-ToMMo Integrated Biobank for Space Life Science (ibSLS): Japanese multi-omics reference panel.
Home Page: https://jmorp.megabank.tohoku.ac.jp/202008/downloads/legacy/

European Space Agency (ESA) - Erasmus Experiment Archive (EEA): A database of ESA funded experiments.
Home Page: https://eea.spaceflight.esa.int/portal/

Other, related NASA Links:

- NASA Life Sciences Data Archive (LSDA): https://lsda.jsc.nasa.gov/
- NASA Astrobiology Habitable Environments Database: https://www.nasa.gov/ames/ahed
- NASA Institutional Scientific Collection (ISC) at Ames Research Center, and Biospecimen Sharing Program (BSP):
- https://www.nasa.gov/ames/research/space-biosciences/isc-bsp
- ISS Microbial Tracking: https://lsda.jsc.nasa.gov/Experiment/exper/13823#data
- HRP Space Radiation Element's NASA Space Radiation Laboratory (NSRL) Biospecimens:

- https://www.nasa.gov/hrp/elements/radiation/about
- NASA Planetary Protection: https://planetaryprotection.jpl.nasa.gov/biological-materials-archive

Links to Study Teams:
Christopher Mason, Ph.D. http://www.masonlab.net/
Susan Bailey, Ph.D. https://vetmedbiosci.colostate.edu/erhs/member/?id=3902
Afshin Beheshti, Ph.D. https://www.linkedin.com/in/afshinbeheshti/
Sylvain Costes, Ph.D. https://www.nasa.gov/ames/research/space-biosciences/sylvain-costes
Peter Grabham, Ph.D. https://www.crr.columbia.edu/profile/peter-grabham

VI. Cell Press Embargo policies

EMBARGO POLICIES

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*We strongly recommend communications include links and/or DOIs to the paper. This information can be accessed from the weekly EurekAlert Tip Sheet and is helpful to reporters and general readers.

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*Social media, particularly Twitter, is one of the most effective ways to quickly get eyes on your work and is one of the primary drivers of traffic to recently published papers. Designate someone on your team to develop a strategy for sharing the news. If you produced a video abstract or Figure 360, you can also embed that into your posts for higher engagement.

*Communications with interesting, shareable images or videos are proven to get more attention. Take pictures during your experiments and prepare high-resolution photos and/or videos. If you are using a professional photographer, ensure, in writing, that you have their permission before freely distributing their work to the media or on social media.

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