ImmPort Webinar: Harnessing NIAID’s ImmPort & NASA’s GeneLab Through Computational and Systems Biology Approach: Determining female health risks for spaceflight driven by microRNAs

Afshin Beheshti, PhD
Professor, Surgery and Computational and Systems Biology
Director, Space Biomedicine Program
Associate Director, McGowan Institute for Regenerative Medicine
beheshti@pitt.edu

University of Pittsburgh
McGowan Institute for Regenerative Medicine

Visiting Researcher
Broad Institute of MIT and Harvard
Cambridge, MA
abehesht@broadinstitute.org

BROAD INSTITUTE

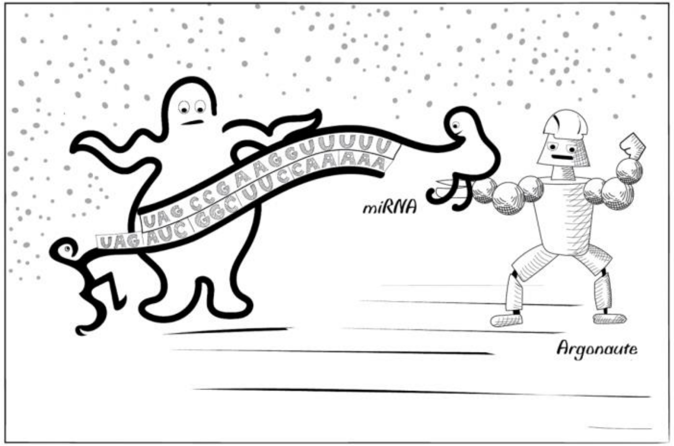
President
COVID-19 International Research Team (COV-IRT) (nonprofit)
afshin.beheshti@cov-irt.org
www.cov-irt.org

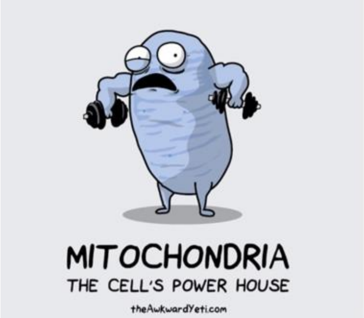
COV-IRT
COVID-19 International Research Team

President
Kwaai (nonprofit)
afshin@kwaai.ai
www.kwaai.ai

Kwaai
Non-Profit Personal AI Lab

Work on Multiple Areas of Research: Central Theme of Research





Systems Biology

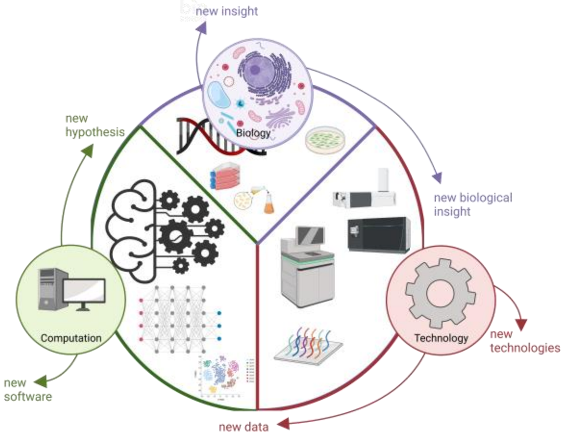
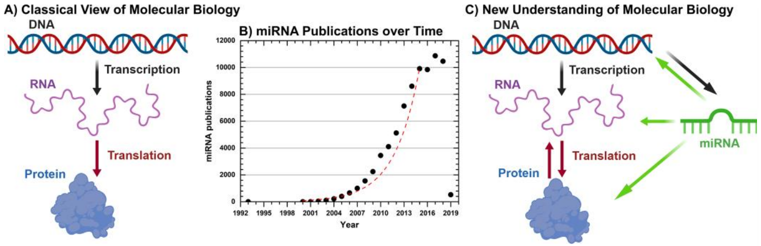
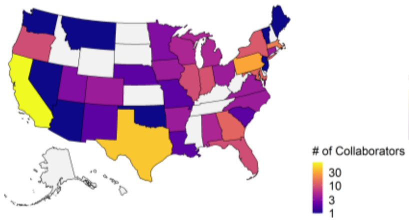
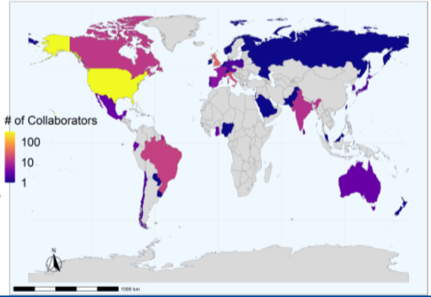


Figure from Vanderburg and Beheshti, MicroRNAs (miRNAs), the Final Frontier: The Hidden Master Regulators Impacting Biological Response in All Organisms Due to Spaceflight, THREE, 2020. https://three.jsc.nasa.gov/Encyclopedia/Article/80



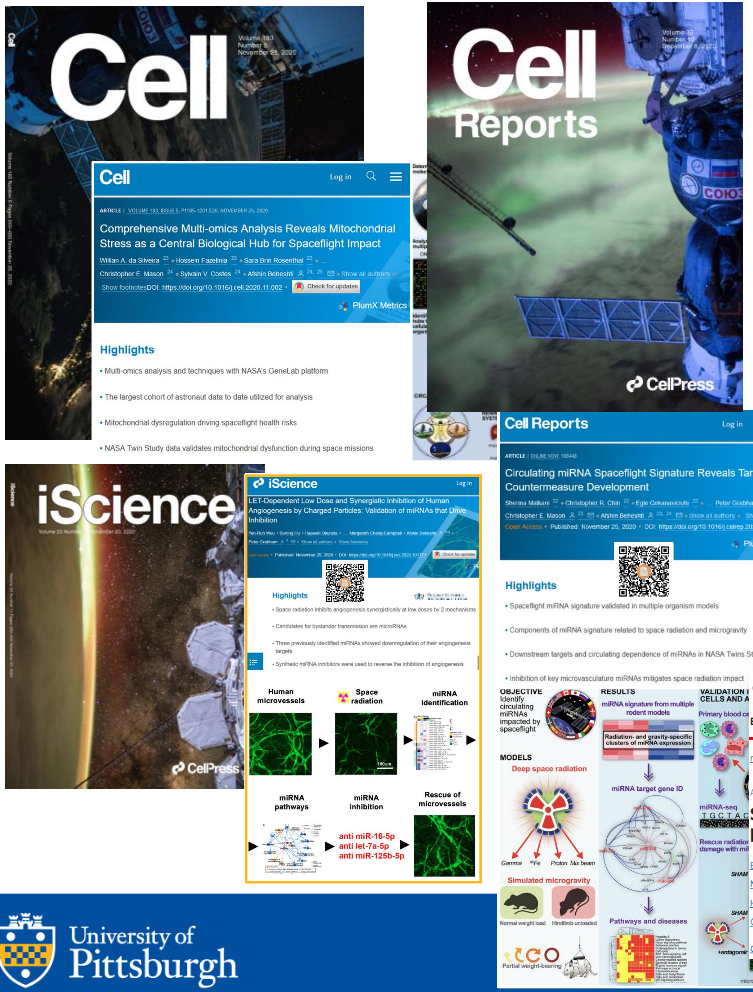
Open Science and Large Network of Collaborators





Work on Multiple Areas of Research: Space Biology

- Space is an accelerated model for aging and mitochondrial disease
- Countermeasures and biomarkers developed for health risks associated with the space environment can easily be applied to similar clinical diseases
- miRNAs as a key biomarker for health risks associated with spaceflight and target for countermeasures
- In general understanding health risks due to spaceflight



Cell Log in

ARTICLE | VOLUME 183, ISSUE 5, P1185-1201.E20, NOVEMBER 25, 2020

Comprehensive Multi-omics Analysis Reveals Mitochondrial Stress as a Central Biological Hub for Spaceflight Impact

Willian A. da Silveira 23 • Hossein Fazelinia 23 • Sara Brin Rosenthal 23 • ... Christopher E. Mason 24 • Sylvain V. Costes 24 • Afshin Beheshti 24, 25 • Show all authors •

Show footnotes DOI: https://doi.org/10.1016/j.cell.2020.11.002 • Check for updates

PlumX Metrics

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

iScience Log in

LET-Dependent Low Dose and Synergistic Inhibition of Human Angiogenesis by Charged Particles: Validation of miRNAs that Drive Inhibition

Yen-Ruh Wuu • Burong Hu • Hazeem Okunola • ... Margareth Cheng-Campbell • Afshin Beheshti • Peter Grabham • Show all authors • Show footnotes

Open Access • Published: November 25, 2020 • DOI: https://doi.org/10.1016/j.isci.2020.101771 • Check for updates

Highlights

- Space radiation inhibits angiogenesis synergistically at low doses by 2 mechanisms
- Candidates for bystander transmission are microRNAs
- Three previously identified miRNAs showed downregulation of their angiogenesis targets
- Synthetic miRNA inhibitors were used to reverse the inhibition of angiogenesis

Cell Reports Log in

ARTICLE | ONLINE NOW, 108448

Circulating miRNA Spaceflight Signature Reveals Targets for Countermeasure Development

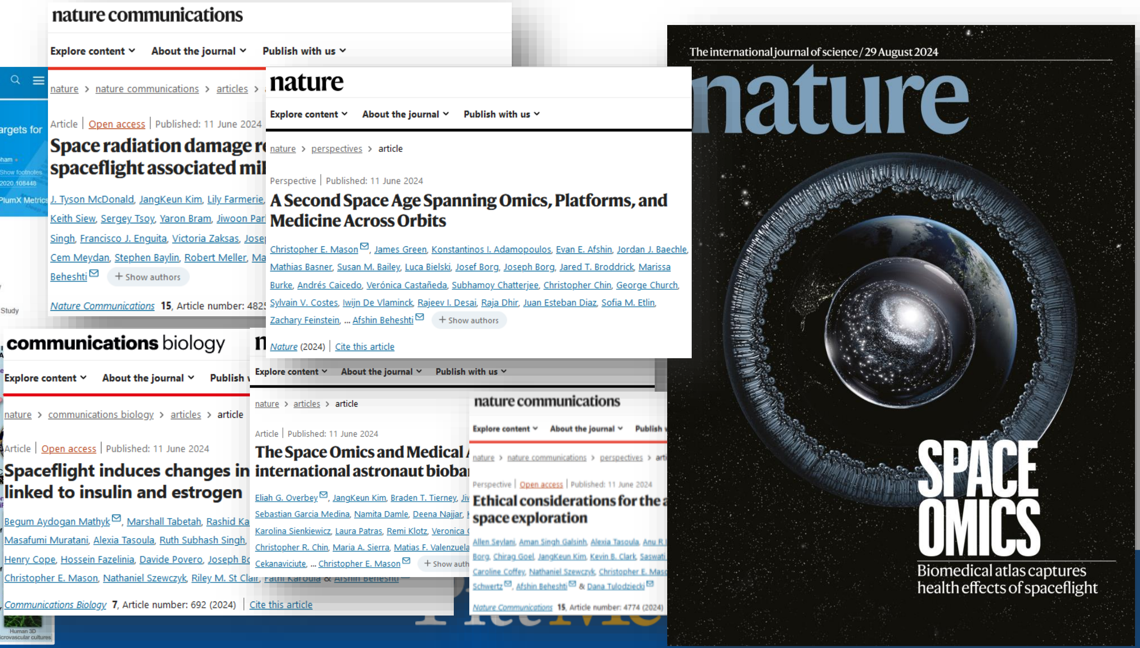
Sherina Malkani 22 • Christopher R. Chin 22 • Egle Cekanaviciute 22 • ... Peter Grabham • Christopher E. Mason 23 • Afshin Beheshti 23, 24 • Show all authors • Show footnotes

Open Access • Published: November 25, 2020 • DOI: https://doi.org/10.1016/j.celrep.2020.108448

PlumX Metrics

Highlights

- 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 Twins Study
- Inhibition of key microvasculature miRNAs mitigates space radiation impact



nature communications

Explore content ⌄ About the journal ⌄ Publish with us ⌄

nature › nature communications › articles ›

Article | Open access | Published: 11 June 2024

Space radiation damage r
spaceflight associated mi

J. Tyson McDonald, JangKeun Kim, Lily Farmerie, Keith Siew, Sergey Tsoy, Yaron Bram, Jiwoon Par Singh, Francisco J. Enguita, Victoria Zaksas, Josep Cem Meydan, Stephen Baylin, Robert Meller, Ma Beheshti + Show authors

Nature Communications 15, Article number: 4825

nature

Explore content ⌄ About the journal ⌄ Publish with us ⌄

nature › perspectives › article

Perspective | Published: 11 June 2024

A Second Space Age Spanning Omics, Platforms, and Medicine Across Orbits

Christopher E. Mason, James Green, Konstantinos I. Adamopoulos, Evan E. Afshin, Jordan J. Baechle, Mathias Basner, Susan M. Bailey, Luca Bielski, Josef Borg, Joseph Borg, Jared T. Broddrick, Marissa Burke, Andrés Caicedo, Verónica Castañeda, Subhamoy Chatterjee, Christopher Chin, George Church, Sylvain V. Costes, Iwijn De Vlaminck, Rajeev I. Desai, Raja Dhir, Juan Esteban Diaz, Sofia M. Etlin, Zachary Feinstein, ... Afshin Beheshti + Show authors

Nature (2024) | Cite this article

communications biology

Explore content ⌄ About the journal ⌄ Publish

nature › communications biology › articles › article

Article | Open access | Published: 11 June 2024

Spaceflight induces changes in
linked to insulin and estrogen

Begum Aydogan Mathyk, Marshall Tabetah, Rashid Ka Masafumi Muratani, Alexia Tasoula, Ruth Subhash Singh, Henry Cope, Hossein Fazelinia, Davide Povero, Joseph Bo Christopher E. Mason, Nathaniel Szewczyk, Riley M. St Clair, Fathi Karouia & Afshin Beheshti

Communications Biology 7, Article number: 692 (2024) | Cite this article

n

Explore content ⌄ About the journal ⌄ Publish with us ⌄

nature › articles › article

Article | Published: 11 June 2024

The Space Omics and Medical
international astronaut bioba

Eliah G. Overbey, JangKeun Kim, Braden T. Tierney, Ji Sebastian Garcia Medina, Namita Damle, Deena Najjar, Karolina Sienkiewicz, Laura Patras, Remi Klotz, Veronica Christopher R. Chin, Maria A. Sierra, Matias F. Valenzuela Cekanaviciute, ... Christopher E. Mason + Show auth

nature communications

Explore content ⌄ About the journal ⌄ Publish

nature › nature communications › perspectives › arti

Perspective | Open access | Published: 11 June 2024

Ethical considerations for the
space exploration

Allen Seylani, Aman Singh Galsinh, Alexia Tasoula, Anu R Borg, Chirag Goel, JangKeun Kim, Kevin B. Clark, Saswati Caroline Coffey, Nathaniel Szewczyk, Christopher E. Maso Schwertz, Afshin Beheshti & Dana Tulodziecki

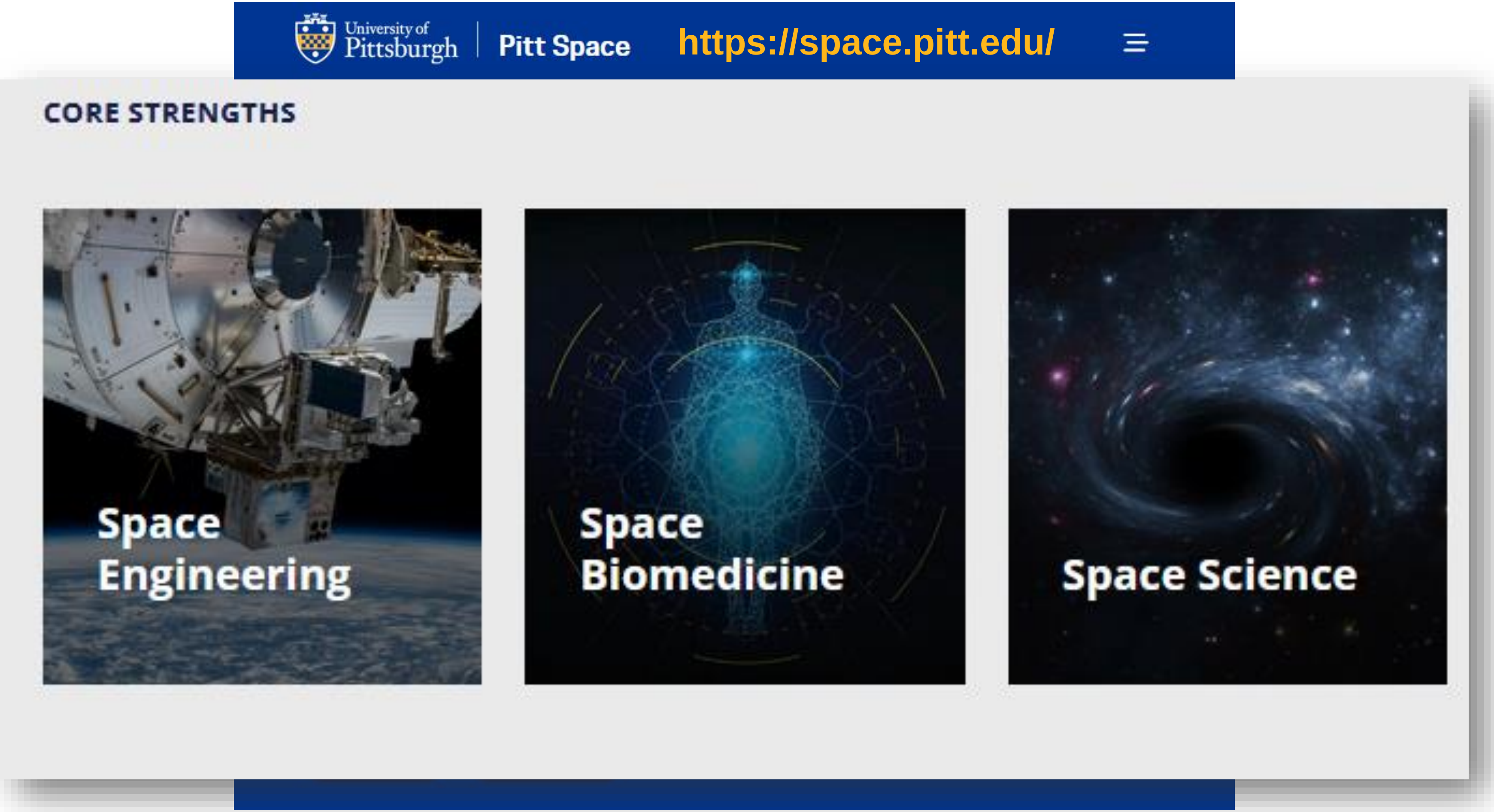
Nature Communications 15, Article number: 4774 (2024)

University of Pittsburgh

https://space.pitt.edu/

Pitt Space Initiative

World-class research and graduates in space engineering, biomedicine, and science to meet the growing needs of the U.S. space community.



University of Pittsburgh | Pitt Space

https://space.pitt.edu/

CORE STRENGTHS

Space Engineering

Space Biomedicine

Space Science

University of Pittsburgh | Pitt Space

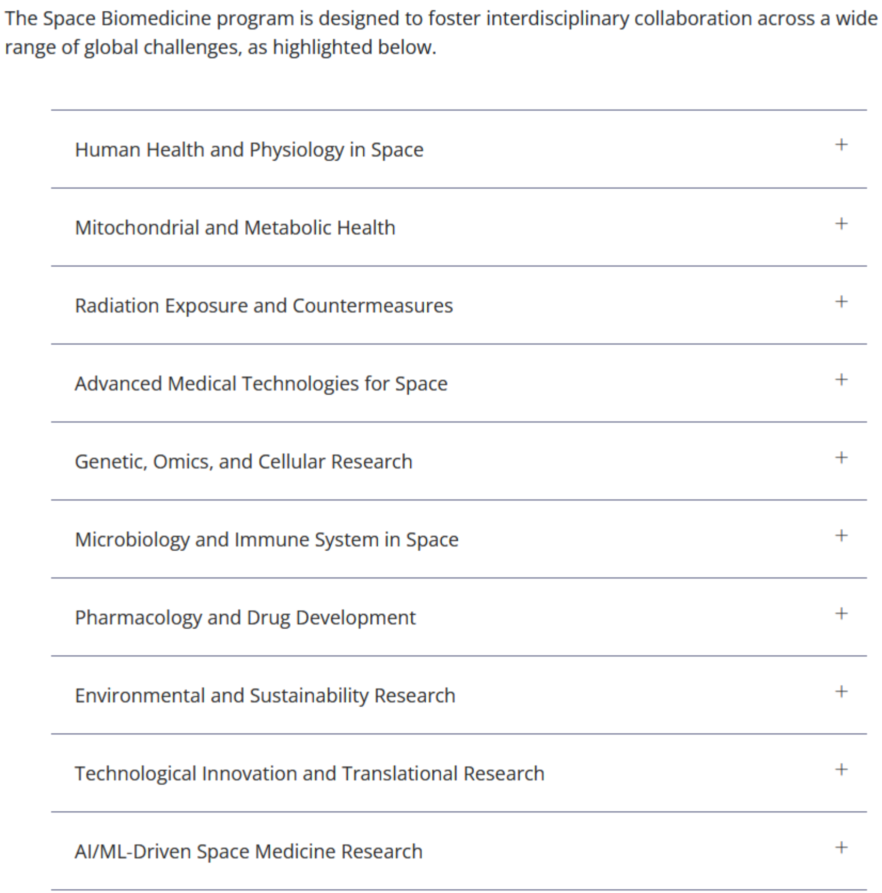
ABOUT

Space Biomedicine

The Space Biomedicine program at the University of Pittsburgh is at the forefront of integrating space biology with advanced biomedical research. Its mission is to develop innovative technologies to safeguard human health and optimize performance in space, while also translating the knowledge gained from space research into solutions for terrestrial healthcare. In addition to its research focus, the program has a second mission: to promote education and outreach in space biomedicine. It aims to establish a robust educational environment that not only supports the University of Pittsburgh but also engages domestic and global partners, preparing the next generation of space researchers and advancing knowledge in this critical field.

Advancing Human Health from Space to Earth

As commercial and private spaceflight activities increase, particularly in low Earth orbit (LEO), the Space Biomedicine program is dedicated to generating impactful discoveries that not only address the challenges of space exploration but also provide tangible solutions for improving human health and environmental sustainability on Earth. The program's collaborative approach ensures that its research outcomes will have broad applications both in space and on Earth, while its educational initiatives will cultivate a new generation of experts in space biology and medicine.



The Space Biomedicine program is designed to foster interdisciplinary collaboration across a wide range of global challenges, as highlighted below.

- Human Health and Physiology in Space +
- Mitochondrial and Metabolic Health +
- Radiation Exposure and Countermeasures +
- Advanced Medical Technologies for Space +
- Genetic, Omics, and Cellular Research +
- Microbiology and Immune System in Space +
- Pharmacology and Drug Development +
- Environmental and Sustainability Research +
- Technological Innovation and Translational Research +
- AI/ML-Driven Space Medicine Research +

https://space.pitt.edu/about/space-biomedicine

Large Collaborative Model for Education and Outreach for the Space Biomedicine Program

Education and Outreach Space Biomedicine Program

The Global Education Certificate Space Program at the University of Pittsburgh (Pitt) aims to establish a cross-institutional and global education initiative that brings together leading academic, industry, and nonprofit entities to educate the next generation of space biology and biomedicine scientists. This innovative program will encompass student exchanges, joint seminars, integrated curricula, and co-teaching by faculty across multiple institutions globally, with Pitt as the central hub.

Education and Outreach Space Biomedicine Program

Initial Ideas for Implementation:

1. **Degree Programs and Curriculum Development:**
   - Develop a curriculum that enables students to earn a degree in Space Biomedicine/Biology. At Pitt, we've already introduced an "Introduction to Space Engineering" course, which has seen high demand. Building on this momentum, we could develop and offer Space Biomedicine courses in future semesters that will be applied as a cross-institutional approach, that would amplify our impact!
2. **Credit Transfer and Course Structure:**
   - Ensure course credits are transferable across all participating institutions. Classes will be available in both in-person and virtual formats. Faculty and scientists from various institutions could co-teach courses, allowing us to leverage diverse expertise and avoid overburdening any single instructor.
3. **Industry and Non-Profit Collaboration:**
   - Collaborate with industry partners to sponsor and support student programs. Industry experts could also provide courses on translating academic research into commercial applications, which is crucial for space biomedicine and rapid deployment of key technologies and countermeasures.
4. **Space Industry Partnerships:**
   - Engage space industry partners such as SpaceX, Axiom, and hardware developers like my collaborator from EcoAtoms and Ice Cubes. As the program develops, we can involve additional partners to broaden our network and capabilities.
5. **Incorporating GeneLab for Universities (GL4U):**
   - Utilize the existing GeneLab 4 University program. We can evolve this into a core component of our curriculum.
6. **Global, Collaborative Effort:**
   - Create a community-driven program that integrates space biomedicine/biology education across institutions. The program will cover foundational to advanced topics, reflecting the rapid advancements in this field.
7. **Support from Space Agencies and Funding Opportunities:**
   - I have had preliminary discussions with a couple people at NASA, and they mentioned there might be potential funds they can provide for such an effort, at least in the US. I will be exploring this further next week. This will probably take a while to put in place, BUT there is very positive and enthusiastic interest.
   - I am also in touch with colleagues at ESA, who are very supportive and keen to participate. I will be discussing this with them in a few weeks.
8. **Nonprofit and Industry Engagement:**
   - Engaging nonprofits and industry stakeholders will be critical. With initial momentum, I believe we can secure their support fairly easily.

Interested Universities and Agencies for Education So Far

Weill Cornell Medicine

UNC
SCHOOL OF MEDICINE
Pharmacology

EVMS
Eastern Virginia Medical School

MGH 1811
MASSACHUSETTS GENERAL HOSPITAL

ChromoLogic

COLORADO STATE UNIVERSITY

HARVARD
MEDICAL SCHOOL

ECOATOMS
SPACE BIOLOGY

THE UNIVERSITY OF CALIFORNIA IRVINE
LET THERE BE LIGHT

Stanford University

Buck
Live better longer.

UCF
UNIVERSITY OF CENTRAL FLORIDA

DEEP SPACE
BIOLOGY

EMBRY-RIDDLE AERONAUTICAL UNIVERSITY
1926

UNIVERSIDAD NACIONAL DE ASUNCION
REPUBLICA DEL PARAGUAY
1889

CellPress

BIOASTRA

Atrium Health
Wake Forest Baptist

L-Università ta' Malta

UCL

THE GUY FOUNDATION

esa
European Space Agency

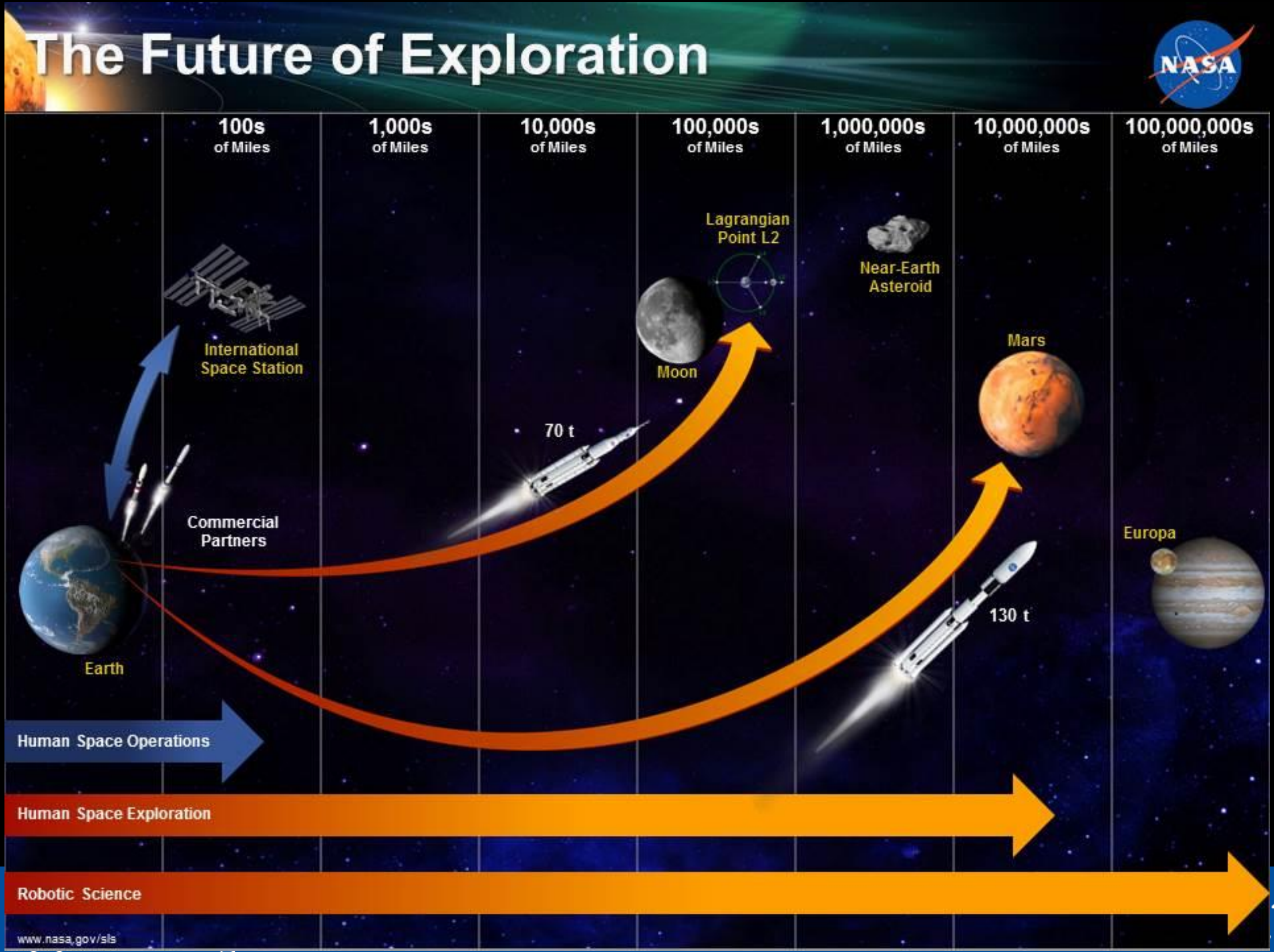
NASA

U LISBOA | UNIVERSIDADE DE LISBOA

University of Lethbridge
FIAT LUX

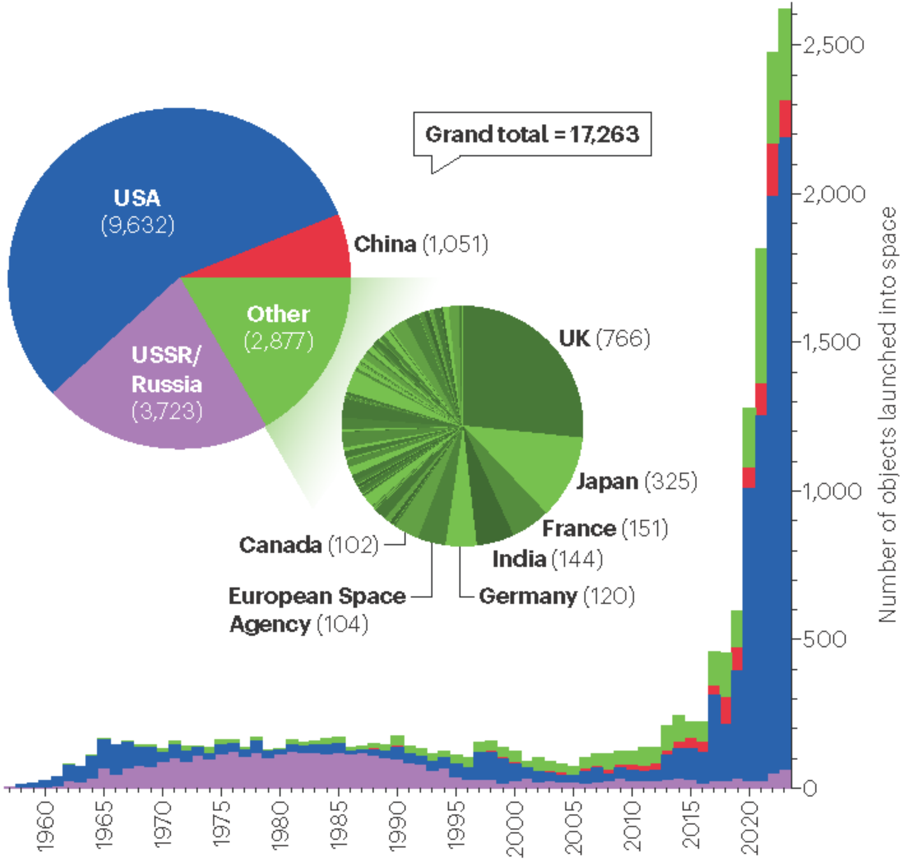
筑波大学
University of Tsukuba

Why Care and Research Space?



and accelerated Mitochondria Disease.
Ultimate platform for accelerated model for many diseases

The Second Space Age



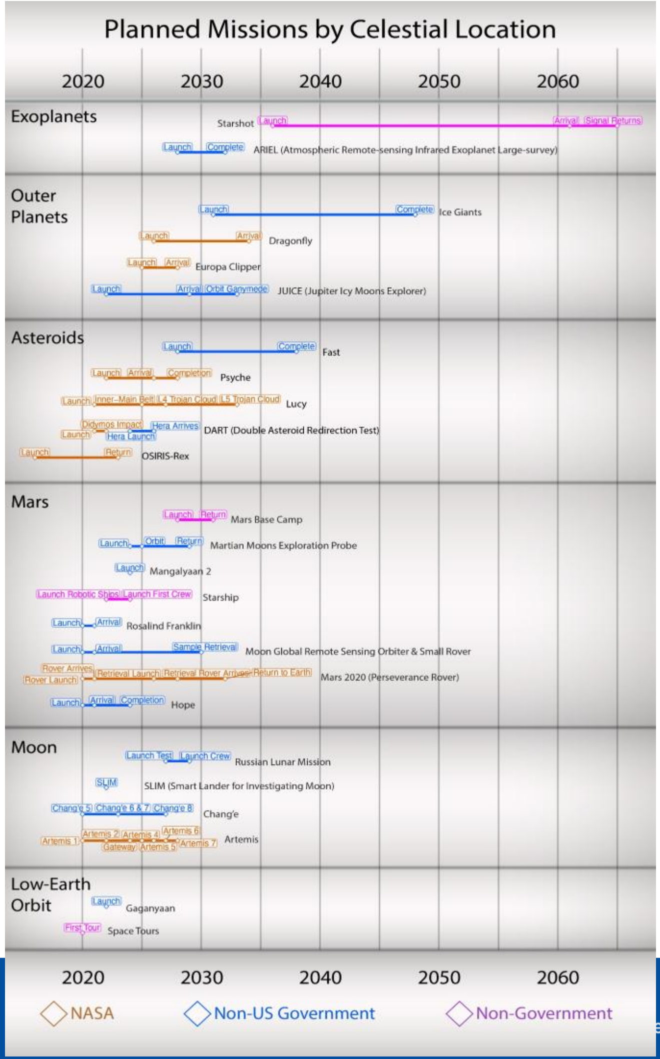
The international journal of science / 29 August 2024

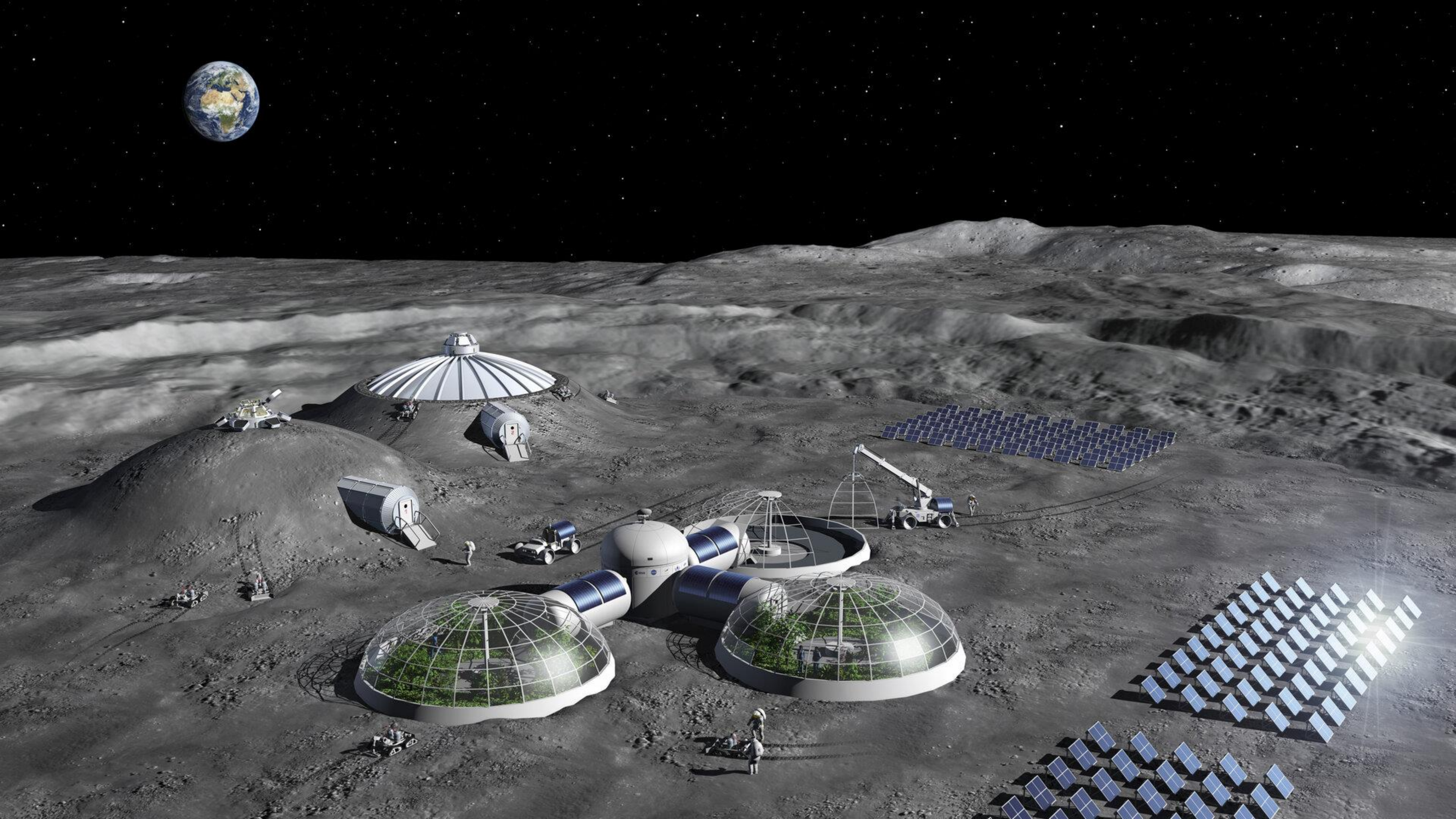
nature

SPACE OMICS

Biomedical atlas captures health effects of spaceflight

The Next Stage of Missions in Space: All Planned Future Space Missions





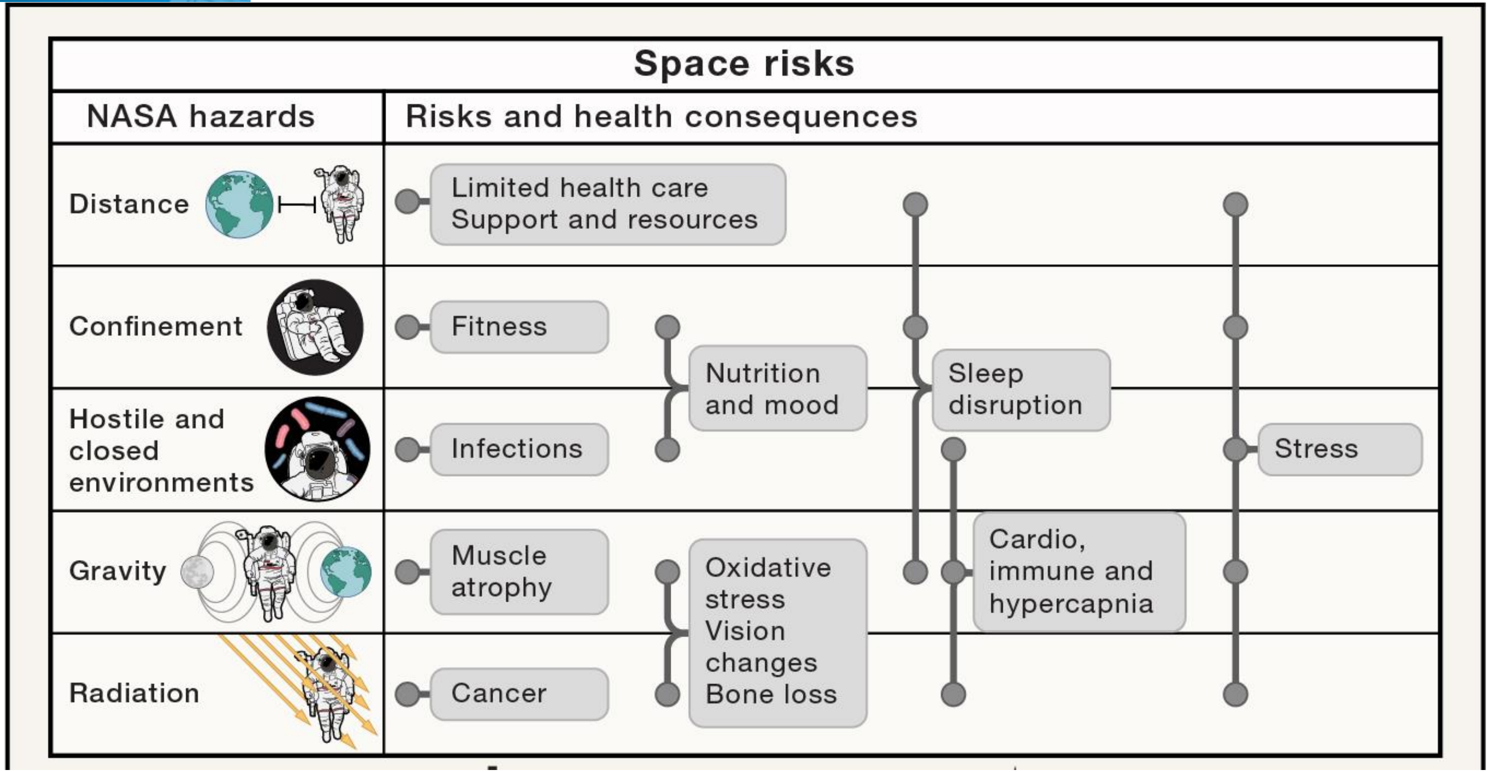
5 Hazards of Spaceflight

Cell

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

Ebrahim Afshinnekoo [34] • Ryan T. Scott [34] • Matthew J. MacKay [34] • … Sylvain V. Costes [35] • Christopher E. Mason [35] • Afshin Beheshti [35] • Show all authors • Show footnotes

DOI: https://doi.org/10.1016/j.cell.2020.10.050 • Check for updates



Space risks

NASA hazards

Risks and health consequences

Distance

Confinement

Hostile and closed environments

Gravity

Radiation

Limited health care Support and resources

Fitness

Infections

Muscle atrophy

Cancer

Nutrition and mood

Oxidative stress Vision changes Bone loss

Sleep disruption

Cardio, immune and hypercapnia

Stress

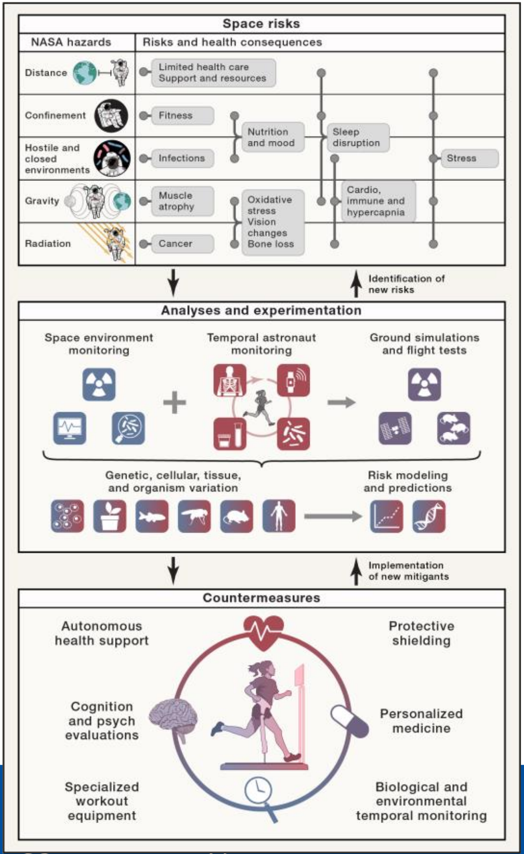
5 Hazards of Spaceflight

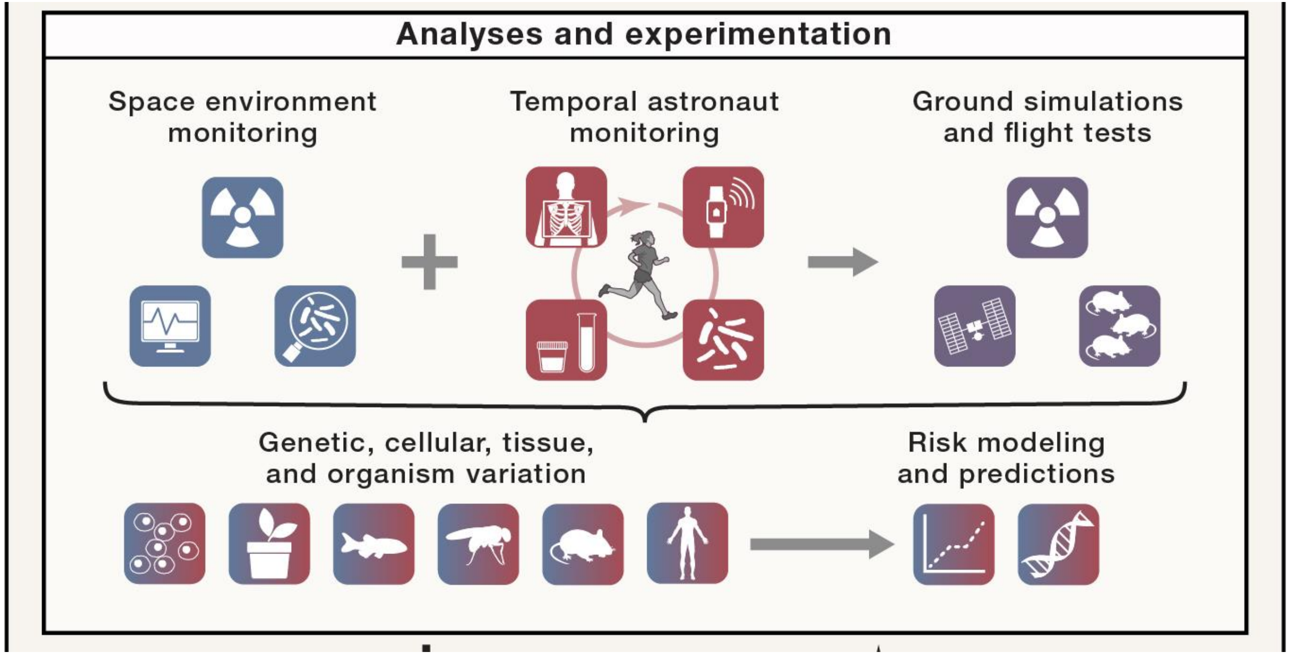
Cell

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

Ebrahim Afshinnekoo [34] • Ryan T. Scott [34] • Matthew J. MacKay [34] • … Sylvain V. Costes [35] • Christopher E. Mason [35] • Afshin Beheshti [35] • Show all authors • Show footnotes

DOI: https://doi.org/10.1016/j.cell.2020.10.050 • Check for updates





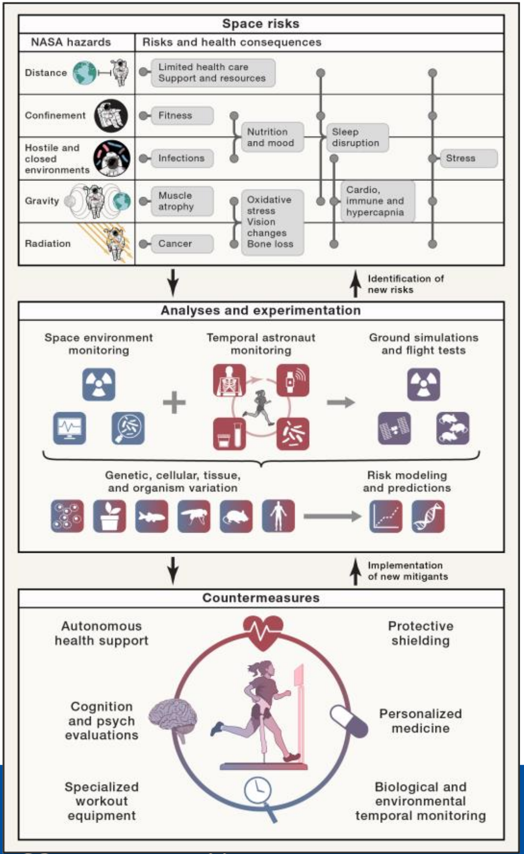
5 Hazards of Spaceflight

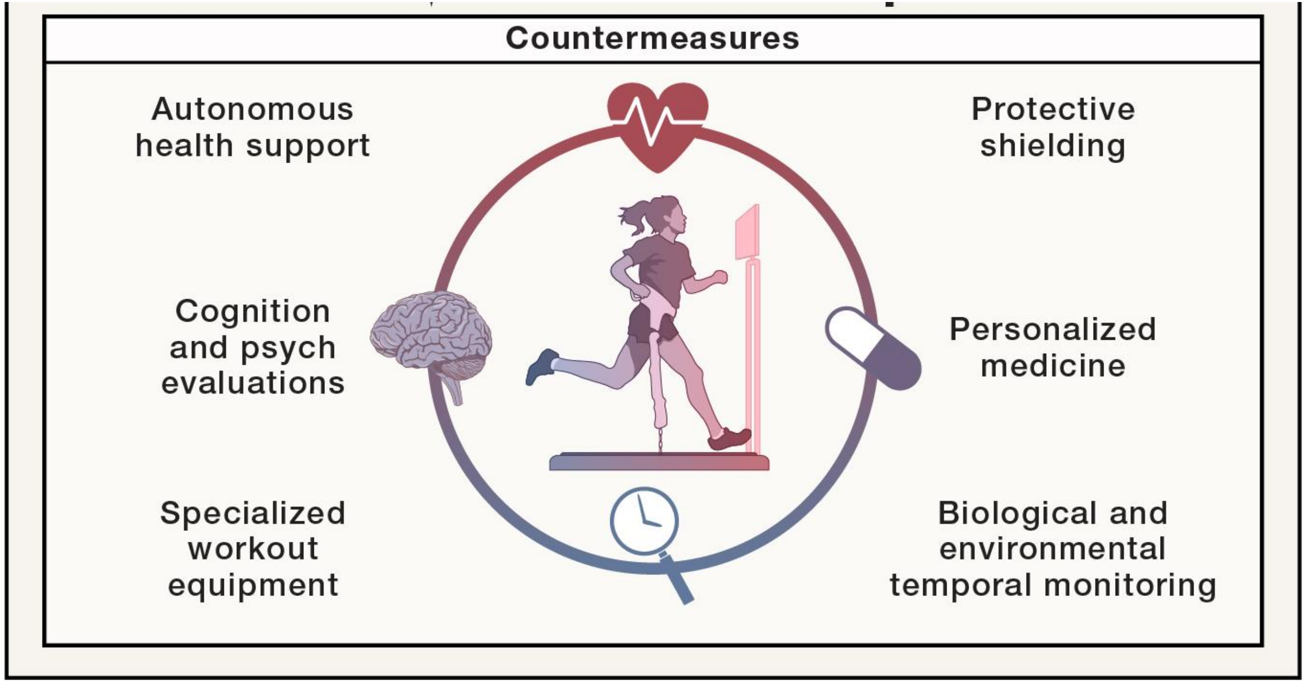
Cell

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

Ebrahim Afshinnekoo [34] • Ryan T. Scott [34] • Matthew J. MacKay [34] • … Sylvain V. Costes [35] • Christopher E. Mason [35] • Afshin Beheshti [35] • Show all authors • Show footnotes

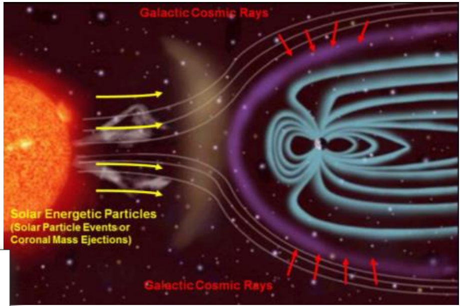
DOI: https://doi.org/10.1016/j.cell.2020.10.050 • Check for updates





Space Environment

Radiation



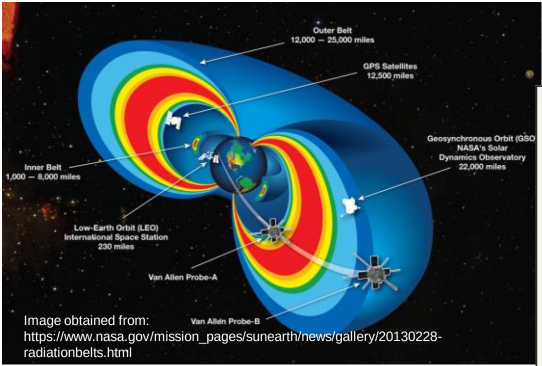


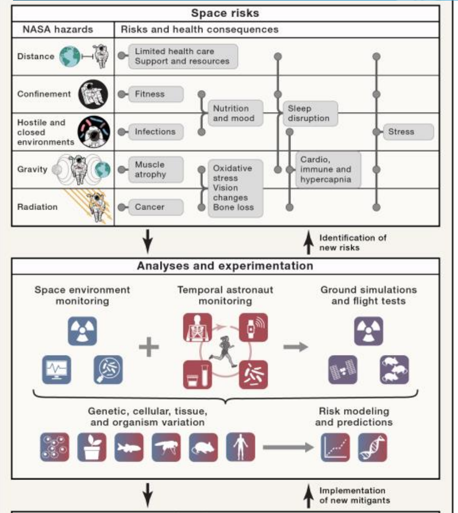
Image obtained from: https://www.nasa.gov/mission_pages/sunearth/news/gallery/20130228-radiationbelts.html

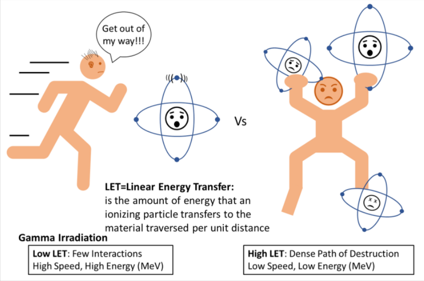
Cell

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

Ebrahim Afshinnekoo 34 • Ryan T. Scott 34 • Matthew J. MacKay 34 • ... Sylvain V. Costes 35 • Christopher E. Mason 35 • Afshin Beheshti 35 • Show all authors • Show footnotes

DOI: https://doi.org/10.1016/j.cell.2020.10.050 • Check for updates

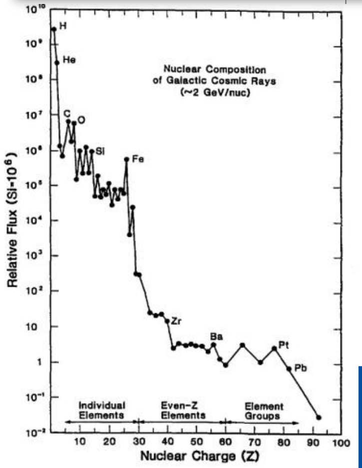


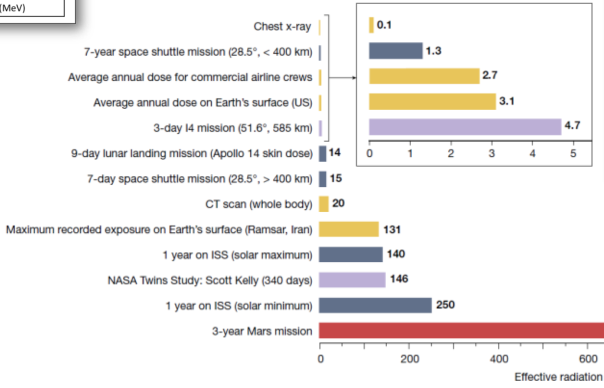


LET=Linear Energy Transfer: is the amount of energy that an ionizing particle transfers to the material traversed per unit distance

Low LET: Few Interactions
High Speed, High Energy (MeV)

High LET: Dense Path of Destruction
Low Speed, Low Energy (MeV)





nature

Explore content ˅ About the journal ˅ Publish with us ˅

nature › perspectives › article

Perspective | Published: 11 June 2024

A Second Space Age Spanning Omics, Platforms, and Medicine Across Orbits

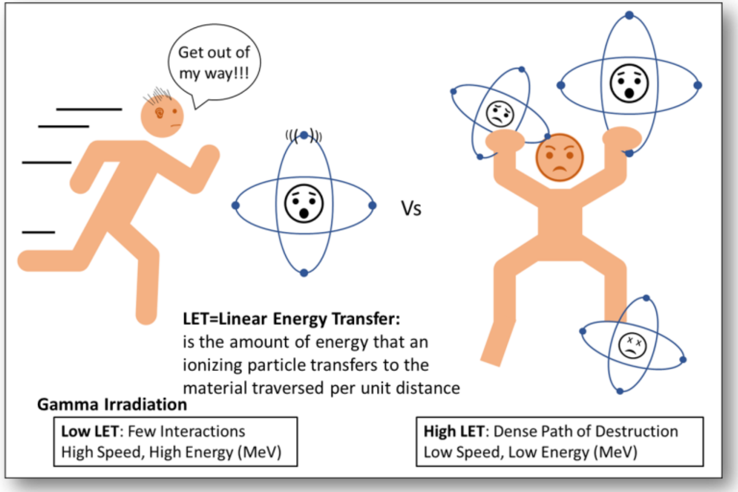
Christopher E. Mason, James Green, Konstantinos I. Adamopoulos, Evan E. Afshin, Jordan J. Baechle, Mathias Basner, Susan M. Bailey, Luca Bielski, Josef Borg, Joseph Borg, Jared T. Broddrick, Marissa Burke, Andrés Caicedo, Verónica Castañeda, Subhamoy Chatterjee, Christopher Chin, George Church, Sylvain V. Costes, Iwijn De Vlaminck, Rajeev I. Desai, Raja Dhir, Juan Esteban Diaz, Sofia M. Etlin, Zachary Feinstein, ... Afshin Beheshti + Show authors

Nature (2024) | Cite this article

Microgravity

Galactic Cosmic Radiation (High LET) – a cautionary tale

Galactic Cosmic Radiation (High LET) – a cautionary tale

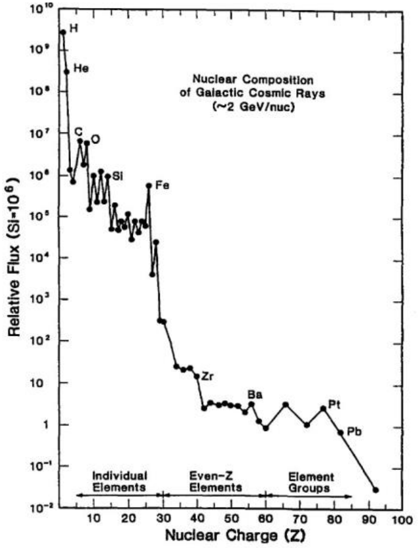


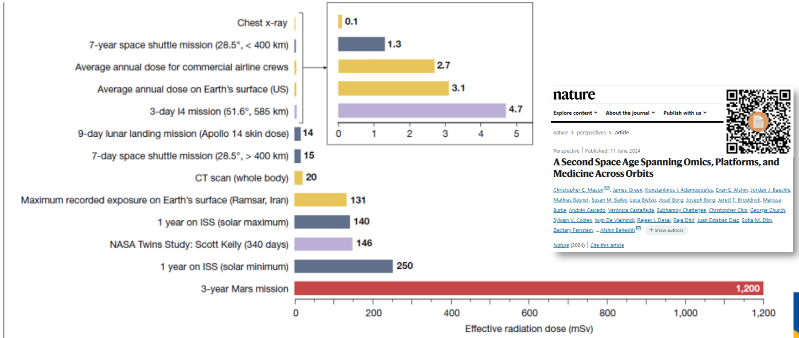
LET=Linear Energy Transfer: is the amount of energy that an ionizing particle transfers to the material traversed per unit distance

Gamma Irradiation

Low LET: Few Interactions
High Speed, High Energy (MeV)

High LET: Dense Path of Destruction
Low Speed, Low Energy (MeV)





nature > perspectives > article

Perspective | Published: 11 June 2024

A Second Space Age Spanning Omics, Platforms, and Medicine Across Orbits

Christopher E. Mason, James Green, Konstantinos I. Adamopoulos, Evan E. Afshin, Jordan J. Baechle, Mathias Basner, Susan M. Bailey, Luca Bielski, Josef Borg, Joseph Borg, Jared T. Broddrick, Marissa Burke, Andrés Caicedo, Verónica Castañeda, Subhamoy Chatterjee, Christopher Chin, George Church, Sylvain V. Costes, Iwijn De Vlaminck, Rajeev I. Desai, Raja Dhir, Juan Esteban Diaz, Sofia M. Etlin, Zachary Feinstein, … Afshin Beheshti + Show authors

Nature (2024) | Cite this article

The reality:

(Would make for a very short Marvel movie)

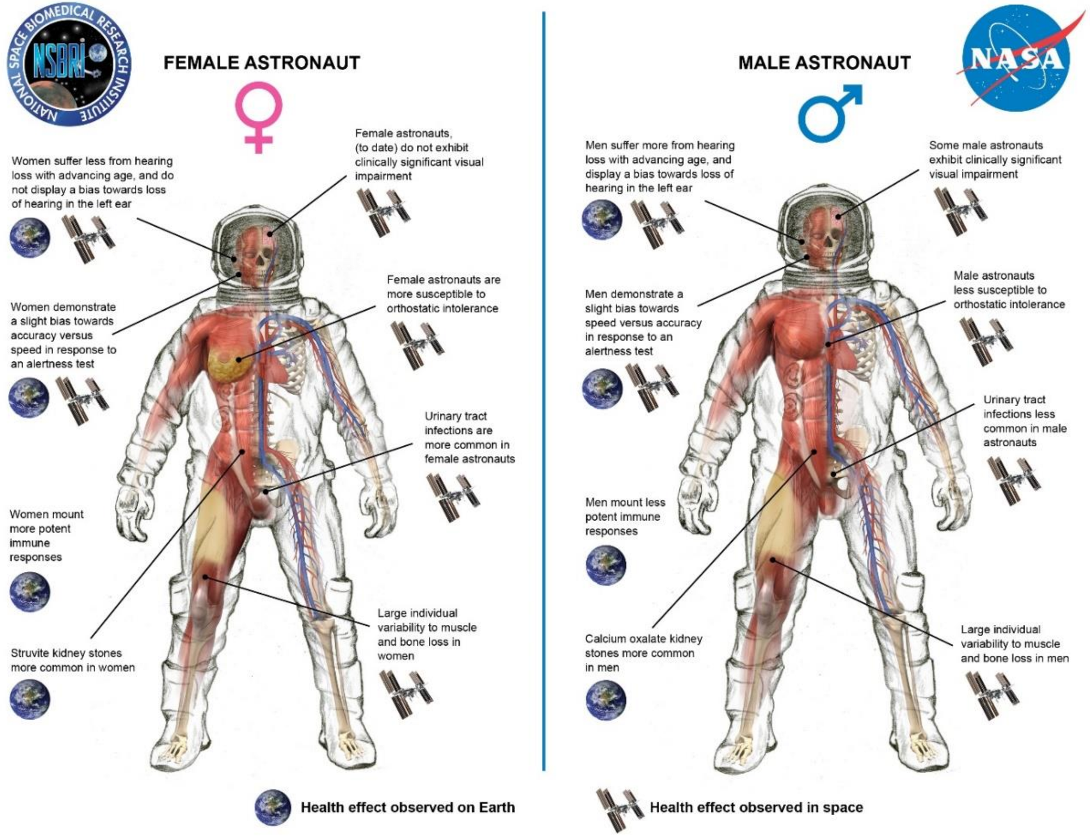
Space Environment Health Risks On Astronauts

Cell

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

Ebrahim Afshinnekoo [34] • Ryan T. Scott [34] • Matthew J. MacKay [34] • … Sylvain V. Costes [35] • Christopher E. Mason [35] • Afshin Beheshti [35] • Show all authors • Show footnotes

DOI: https://doi.org/10.1016/j.cell.2020.10.050 • Check for updates



FEMALE ASTRONAUT

Women suffer less from hearing loss with advancing age, and do not display a bias towards loss of hearing in the left ear

Female astronauts, (to date) do not exhibit clinically significant visual impairment

Female astronauts are more susceptible to orthostatic intolerance

Women demonstrate a slight bias towards accuracy versus speed in response to an alertness test

Urinary tract infections are more common in female astronauts

Women mount more potent immune responses

Large individual variability to muscle and bone loss in women

Struvite kidney stones more common in women

MALE ASTRONAUT

Men suffer more from hearing loss with advancing age, and display a bias towards loss of hearing in the left ear

Some male astronauts exhibit clinically significant visual impairment

Men demonstrate a slight bias towards speed versus accuracy in response to an alertness test

Male astronauts less susceptible to orthostatic intolerance

Urinary tract infections less common in male astronauts

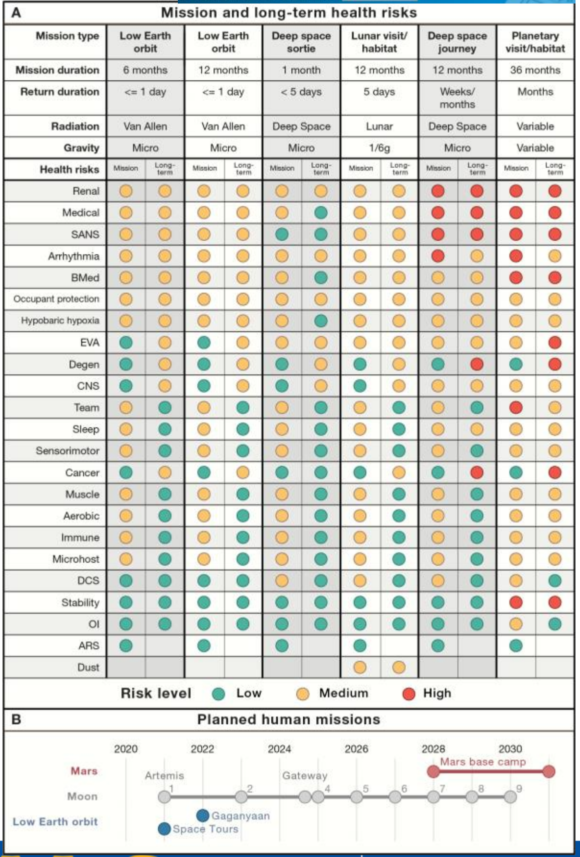
Men mount less potent immune responses

Calcium oxalate kidney stones more common in men

Large individual variability to muscle and bone loss in men

Health effect observed on Earth

Health effect observed in space



A Mission and long-term health risks

Mission type	Low Earth orbit		Low Earth orbit		Deep space sortie		Lunar visit/ habitat		Deep space journey		Planetary visit/habitat	
Mission duration	6 months		12 months		1 month		12 months		12 months		36 months	
Return duration	<= 1 day		<= 1 day		< 5 days		5 days		Weeks/ months		Months	
Radiation	Van Allen		Van Allen		Deep Space		Lunar		Deep Space		Variable	
Gravity	Micro		Micro		Micro		1/6g		Micro		Variable	
Health risks	Mission	Long-term	Mission	Long-term	Mission	Long-term	Mission	Long-term	Mission	Long-term	Mission	Long-term
Renal	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🔴	🔴	🔴	🔴
Medical	🟠	🟠	🟠	🟠	🟠	🟢	🟠	🟠	🔴	🔴	🔴	🔴
SANS	🟠	🟠	🟠	🟠	🟢	🟢	🟠	🟠	🔴	🔴	🔴	🔴
Arrhythmia	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🔴	🟠	🔴	🟠
BMed	🟠	🟠	🟠	🟠	🟠	🟢	🟠	🟠	🟠	🟠	🔴	🔴
Occupant protection	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠
Hypobaric hypoxia	🟠	🟠	🟠	🟠	🟠	🟢	🟠	🟠	🟠	🟠	🟠	🟠
EVA	🟢	🟠	🟢	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🔴
Degen	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🔴	🟢	🔴
CNS	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟠	🟠	🟠	🟠
Team	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🔴	🟠
Sleep	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟠	🟠	🟠
Sensorimotor	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟠
Cancer	🟢	🟠	🟢	🟠	🟢	🟢	🟢	🟠	🟢	🔴	🟢	🔴
Muscle	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟠
Aerobic	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟠
Immune	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟠
Microhost	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟠
DCS	🟢	🟢	🟢	🟢	🟠	🟢	🟠	🟢	🟠	🟢	🟠	🟢
Stability	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴
OI	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟠	🟢
ARS	🟢		🟢		🟢		🟢		🟢		🟢	
Dust							🟠	🟠				

Risk level 🟢 Low 🟠 Medium 🔴 High

B Planned human missions

Type of Experiments Related to Space Biology

Experiments Done in Space

articles Advanced

FOR LIBRARIANS PUBLISH VIDEO JOURNAL

ABSTRACT INTRODUCTION PROTOCOL RESULTS DISCUSSION MATERIALS

GENETICS

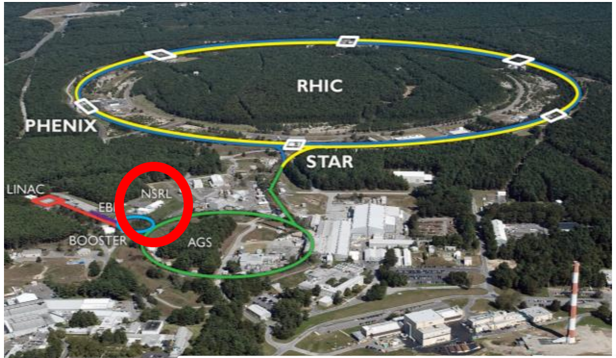
Exploring the Effects of Spaceflight on Mouse Physiology using the Open Access NASA GeneLab Platform

Afshin Beheshti[1], Yasaman Shirazi-Fard[2], Sungshin Choi[1], Daniel Berrios[3], Samrawit G. Gebre[1], Jonathan M. Galazka[2], Sylvain V. Costes[2]

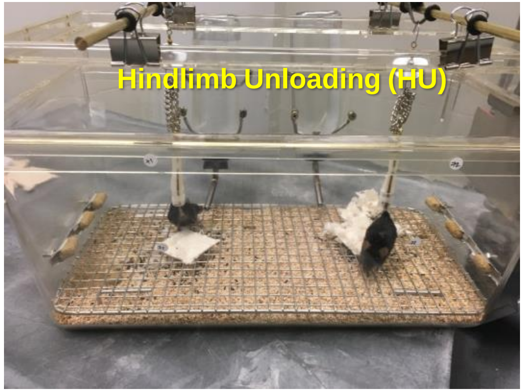
[1]WYLE Labs, Space Biosciences Division, **NASA Ames Research Center**, [2]Space Biosciences Division, **NASA Ames Research Center**, [3]USRA, **NASA Ames Research Center**

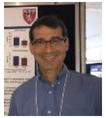
Space Radiation Simulated Experiments

Brookhaven National Laboratory



Microgravity Simulated Experiments




Seward Rutkove


Marie Mortreux

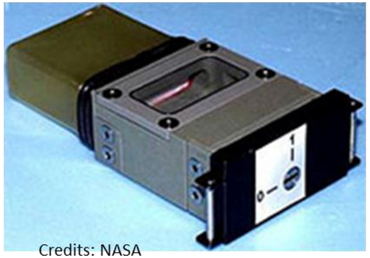
Beth Israel Deaconess Medical Center

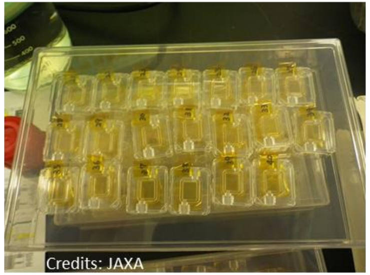
University of Pittsburgh

Pitt McGowan Institute for Regenerative Medicine

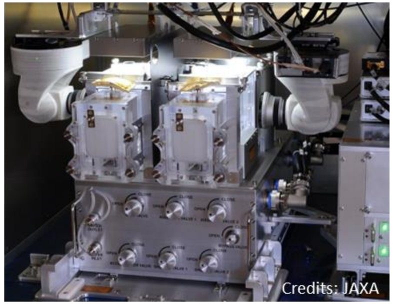
https://www.rutkovelab.org/nasa/

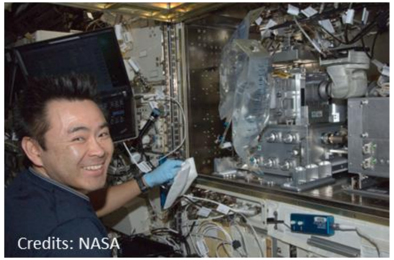
Type of Experiments Related to Space Biology


Credits: NASA


Credits: JAXA

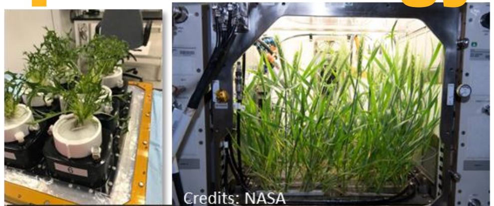
C. elegans culture chambers for the Space Aging experiment aboard the ISS


Credits: JAXA


Credits: NASA

The Zebrafish Muscle investigation employs the ISS Aquatic Habitat, an aquarium in microgravity.


Credits: NASA


Credits: NASA

emergence of mustard seedlings

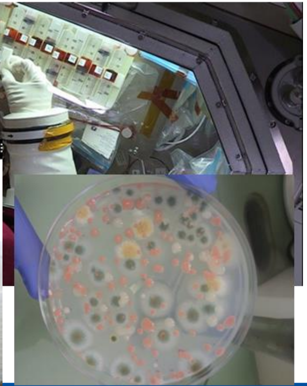

Credits: NASA

ISS004E8728


Interior view of an incubator cassette from the Bioculture System

Credits: NASA/Ames Research Cent

Credits: NASA / JPL




SCIENCELINE

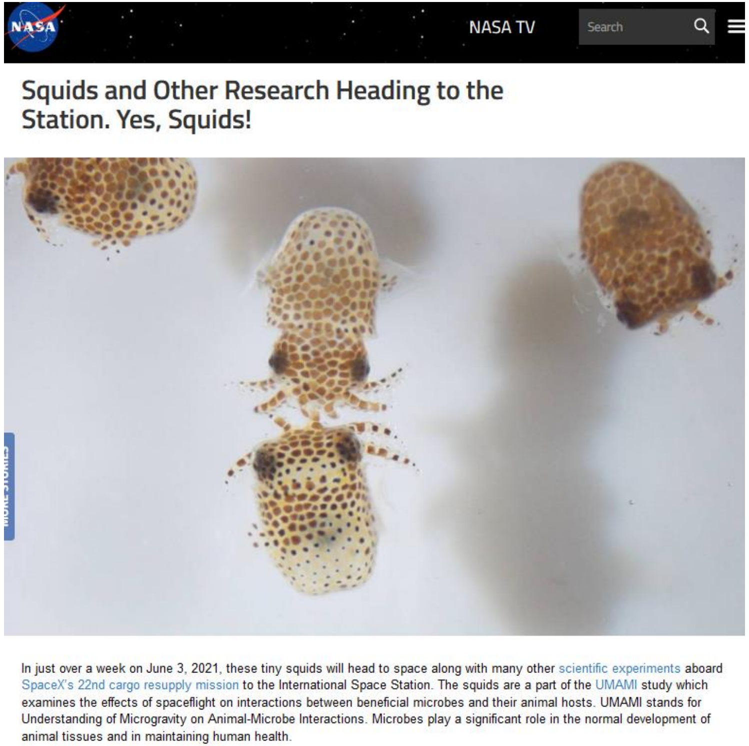
Why fungi adapt so well to life in space

In many ways, these little microbes are better prepared for space travel than we are

MATTHEW PHELAN • MARCH 7, 2018

Crew members routinely take air, water and surface samples on the International Space Station to monitor changes in the microbiome for their personal health and safety. [Image credit: NASA | Public Domain]

Type of Experiments Related to Space Biology



NASA TV

Search

Squids and Other Research Heading to the Station. Yes, Squids!

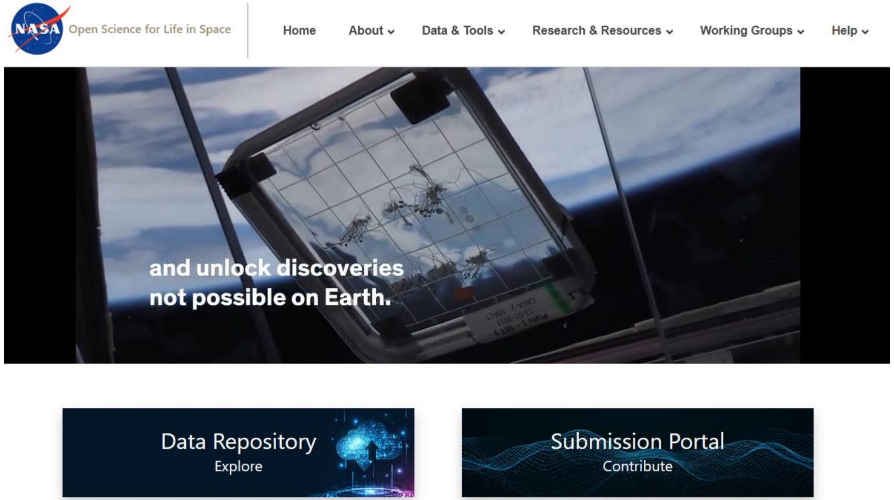
In just over a week on June 3, 2021, these tiny squids will head to space along with many other scientific experiments aboard SpaceX's 22nd cargo resupply mission to the International Space Station. The squids are a part of the UMAMI study which examines the effects of spaceflight on interactions between beneficial microbes and their animal hosts. UMAMI stands for Understanding of Microgravity on Animal-Microbe Interactions. Microbes play a significant role in the normal development of animal tissues and in maintaining human health.

Newly hatched squid right before being added to the spaceflight hardware. (Photo credit: Jamie Foster)

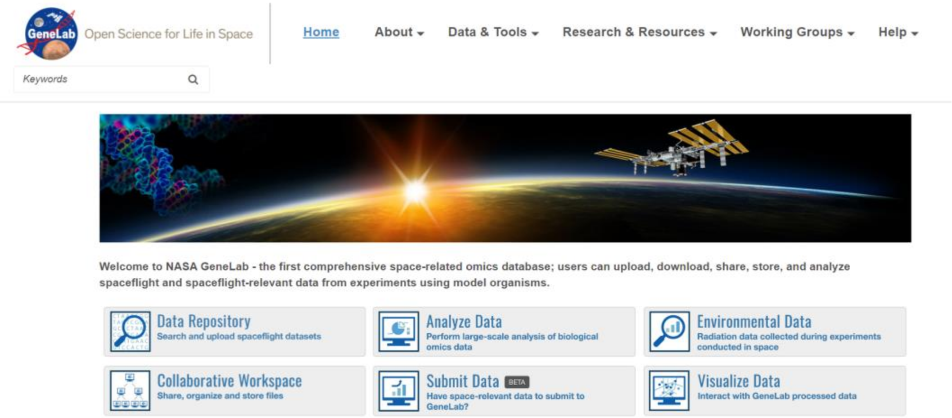
Hatchling squid in their space aquariums. (Photo credit: Jamie Foster)

Space Omics/Data Platform that The Public can Use!!

https://osdr.nasa.gov



and unlock discoveries not possible on Earth.

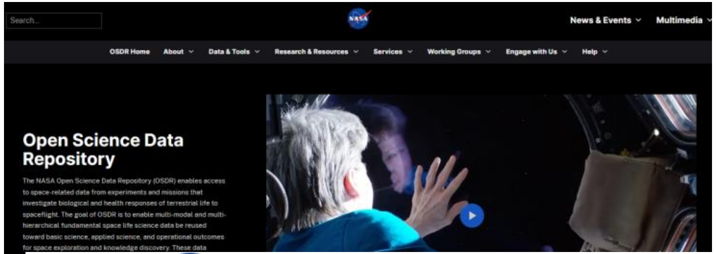


Welcome to NASA GeneLab - the first comprehensive space-related omics database; users can upload, download, share, store, and analyze spaceflight and spaceflight-relevant data from experiments using model organisms.

GeneLab Multi-Omics Analysis Working Group

https://osdr.nasa.gov

https://www.nasa.gov/osdr-working-groups-awg-about/



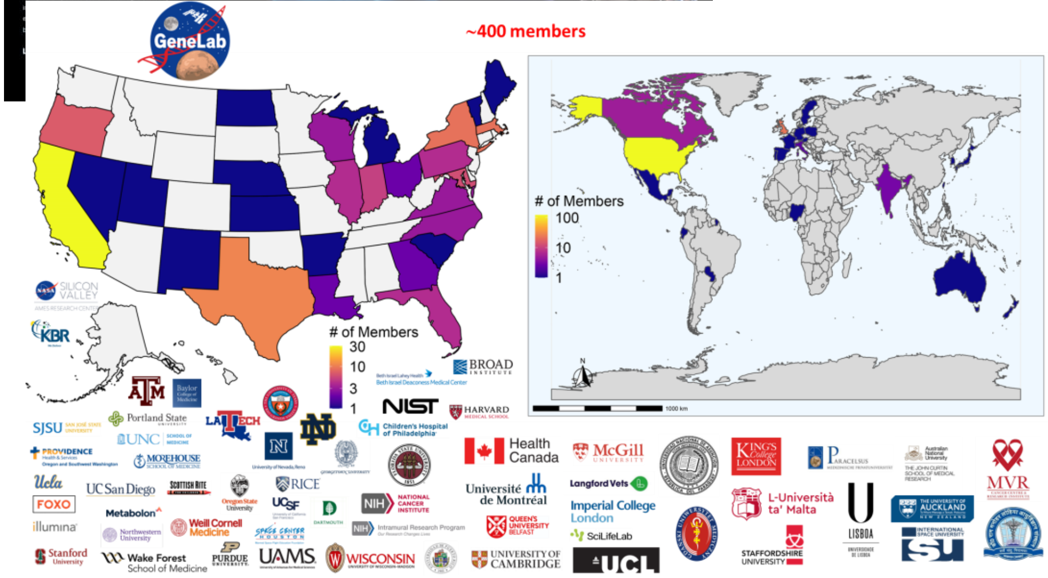
Search...

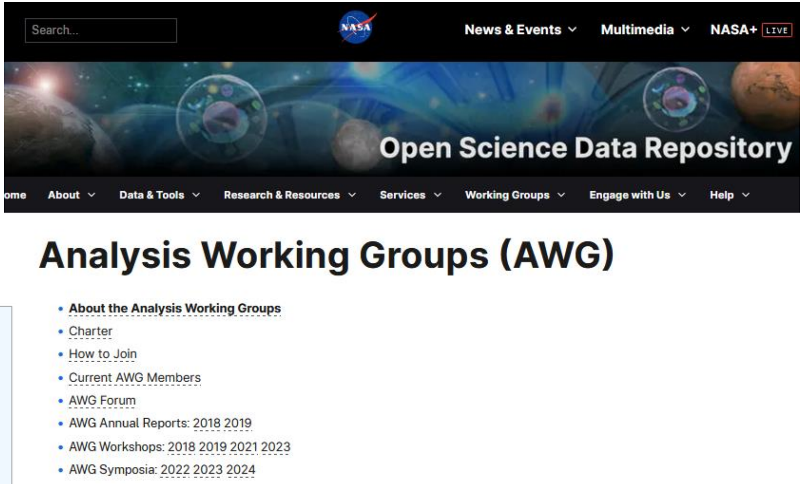
News & Events ⌄ Multimedia ⌄

OSDR Home About ⌄ Data & Tools ⌄ Research & Resources ⌄ Services ⌄ Working Groups ⌄ Engage with Us ⌄ Help ⌄

Open Science Data Repository

The NASA Open Science Data Repository (OSDR) enables access to space-related data from experiments and missions that investigate biological and health responses of terrestrial life to spaceflight. The goal of OSDR is to enable multi-modal and multi-hierarchical fundamental space life science data be reused toward basic science, applied science, and operational outcomes for space exploration and knowledge discovery. These data





Search...

News & Events ⌄ Multimedia ⌄ NASA+ LIVE

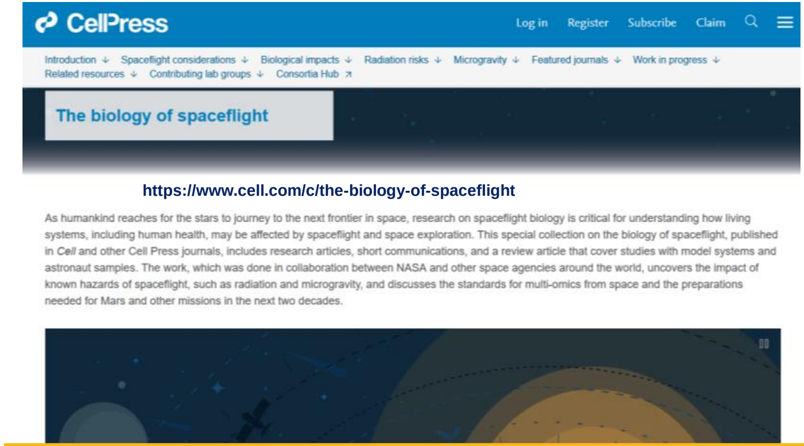
Open Science Data Repository

ome About ⌄ Data & Tools ⌄ Research & Resources ⌄ Services ⌄ Working Groups ⌄ Engage with Us ⌄ Help ⌄

Analysis Working Groups (AWG)

- **About the Analysis Working Groups**
- Charter
- How to Join
- Current AWG Members
- AWG Forum
- AWG Annual Reports: 2018 2019
- AWG Workshops: 2018 2019 2021 2023
- AWG Symposia: 2022 2023 2024

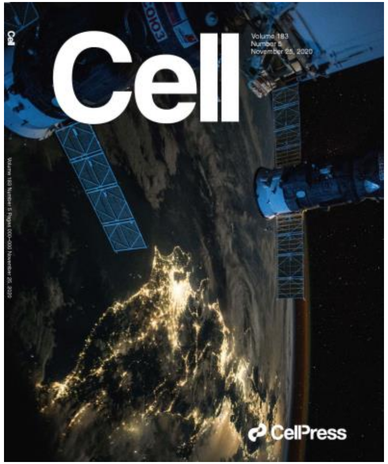
Lots of Papers Published on Space Biology in 11/2020!!



The biology of spaceflight

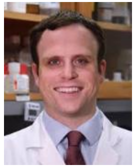
https://www.cell.com/c/the-biology-of-spaceflight

As humankind reaches for the stars to journey to the next frontier in space, research on spaceflight biology is critical for understanding how living systems, including human health, may be affected by spaceflight and space exploration. This special collection on the biology of spaceflight, published in *Cell* and other Cell Press journals, includes research articles, short communications, and a review article that cover studies with model systems and astronaut samples. The work, which was done in collaboration between NASA and other space agencies around the world, uncovers the impact of known hazards of spaceflight, such as radiation and microgravity, and discusses the standards for multi-omics from space and the preparations needed for Mars and other missions in the next two decades.



Afshin Beheshti

University of Pittsburgh
McGowan Institute for Regenerative Medicine

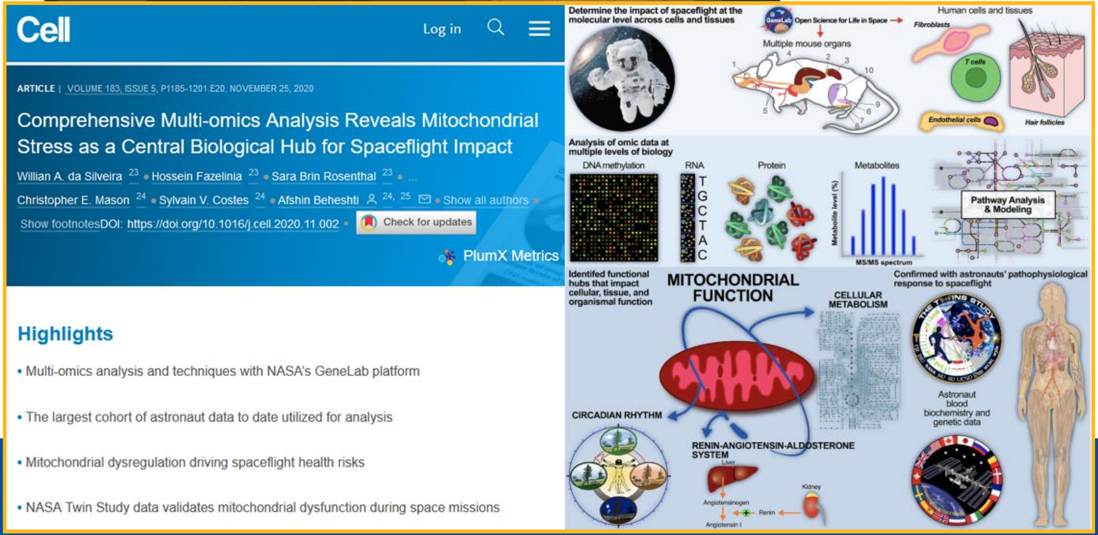


Chris Mason

Weill Cornell Medicine

Susan Bailey

COLORADO STATE UNIVERSITY



ARTICLE | VOLUME 183, ISSUE 5, P1185-1201.E20, NOVEMBER 25, 2020

Comprehensive Multi-omics Analysis Reveals Mitochondrial Stress as a Central Biological Hub for Spaceflight Impact

Willian A. da Silveira [23] • Hossein Fazelinia [23] • Sara Brin Rosenthal [23] • ... Christopher E. Mason [24] • Sylvain V. Costes [24] • Afshin Beheshti [24, 25]

DOI: https://doi.org/10.1016/j.cell.2020.11.002

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

New Nature Portfolio Paper Package Launched on June 11th 2024!!

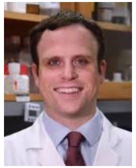
nature portfolio

Space Omics and Medical Atlas (SOMA) across orbits

New studies on astronauts and space biology bring humanity one step closer to the final frontier

Afshin Beheshti

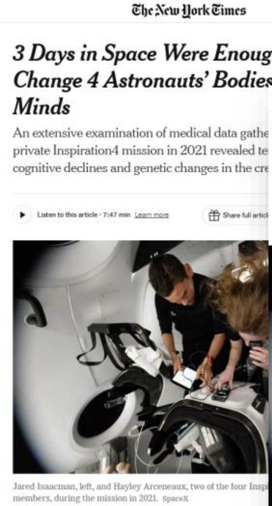
University of Pittsburgh
McGowan Institute for Regenerative Medicine



Chris Mason

Weill Cornell Medicine

- Central theme around the Inspiration 4 mission, JAXA missions, and commercial missions in general
- 44 space biology related papers total part of the package

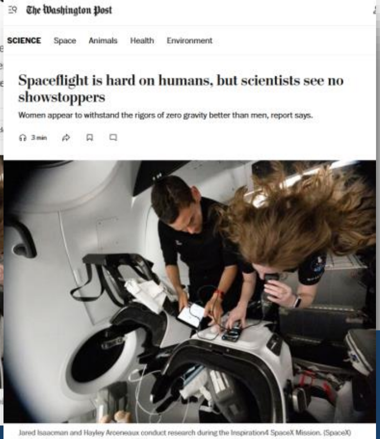


The New York Times

3 Days in Space Were Enough to Change 4 Astronauts' Bodies and Minds

An extensive examination of medical data gathe
private Inspiration4 mission in 2021 revealed te
cognitive declines and genetic changes in the cre

Jared Isaacman, left, and Hayley Arceneaux, two of the four Insp
members, during the mission in 2021. SpaceX

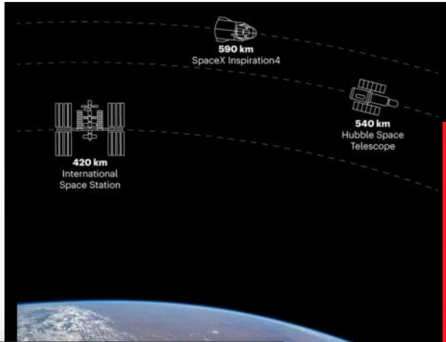


The Washington Post

Spaceflight is hard on humans, but scientists see no showstoppers

Women appear to withstand the rigors of zero gravity better than men, report says.

Jared Isaacman and Hayley Arceneaux conduct research during the Inspiration4 SpaceX Mission. (SpaceX)

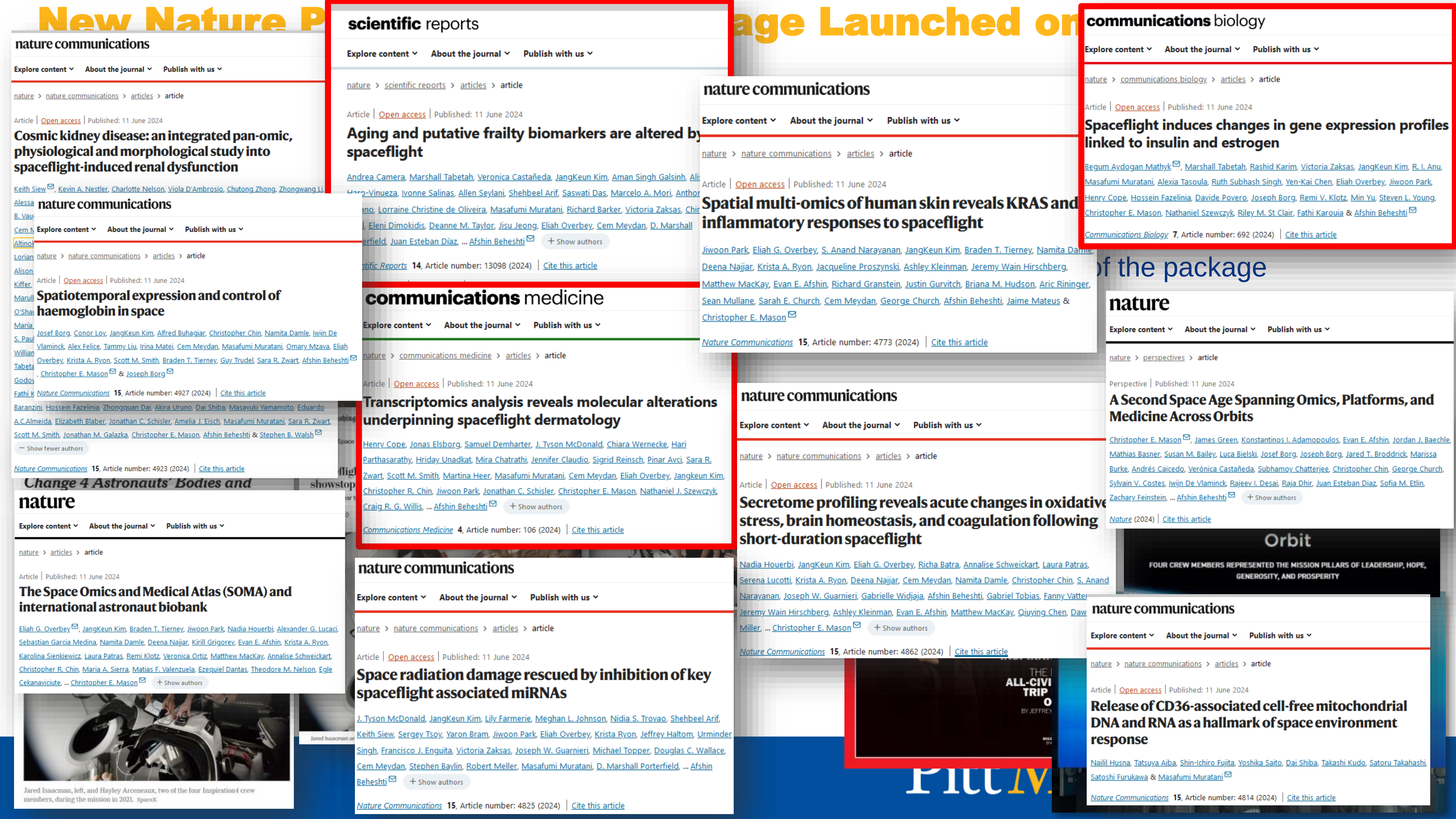


New research explores how a short trip to space affects the human body

The First All-Civilian Mission To Orbit

FOUR CREW MEMBERS REPRESENTED THE MISSION PILLARS OF LEADERSHIP, HOPE, GENEROSITY, AND PROSPERITY

New Nature P … age Launched on … of the package



nature communications

Explore content ˅ About the journal ˅ Publish with us ˅

nature › nature communications › articles › article

Article | Open access | Published: 11 June 2024

Cosmic kidney disease: an integrated pan-omic, physiological and morphological study into spaceflight-induced renal dysfunction

Keith Siew ✉, Kevin A. Nestler, Charlotte Nelson, Viola D'Ambrosio, Chutong Zhong, Zhongwang Li,
Alessa
B. Vau
Cem M
Altinok
Lorian
Alison
Kiffer,
Marull
O'Shau
María
S. Paul
Willian
Tabeta
Godov
Fathi K
Baranzini, Hossein Fazelinia, Zhongquan Dai, Akira Uruno, Dai Shiba, Masayuki Yamamoto, Eduardo A.C.Almeida, Elizabeth Blaber, Jonathan C. Schisler, Amelia J. Eisch, Masafumi Muratani, Sara R. Zwart, Scott M. Smith, Jonathan M. Galazka, Christopher E. Mason, Afshin Beheshti & Stephen B. Walsh ✉

— Show fewer authors

Nature Communications **15**, Article number: 4923 (2024) | Cite this article

---

nature communications

Explore content ˅ About the journal ˅ Publish with us ˅

nature › nature communications › articles › article

Article | Open access | Published: 11 June 2024

Spatiotemporal expression and control of haemoglobin in space

Josef Borg, Conor Loy, JangKeun Kim, Alfred Buhagiar, Christopher Chin, Namita Damle, Iwijn De Vlaminck, Alex Felice, Tammy Liu, Irina Matei, Cem Meydan, Masafumi Muratani, Omary Mzava, Eliah Overbey, Krista A. Ryon, Scott M. Smith, Braden T. Tierney, Guy Trudel, Sara R. Zwart, Afshin Beheshti ✉, Christopher E. Mason ✉ & Joseph Borg ✉

Nature Communications **15**, Article number: 4927 (2024) | Cite this article

---

scientific reports

Explore content ˅ About the journal ˅ Publish with us ˅

nature › scientific reports › articles › article

Article | Open access | Published: 11 June 2024

Aging and putative frailty biomarkers are altered by spaceflight

Andrea Camera, Marshall Tabetah, Veronica Castañeda, JangKeun Kim, Aman Singh Galsinh, Ali
Haro-Vinueza, Ivonne Salinas, Allen Seylani, Shehbeel Arif, Saswati Das, Marcelo A. Mori, Anthor
ano, Lorraine Christine de Oliveira, Masafumi Muratani, Richard Barker, Victoria Zaksas, Chir
l, Eleni Dimokidis, Deanne M. Taylor, Jisu Jeong, Eliah Overbey, Cem Meydan, D. Marshall
erfield, Juan Esteban Díaz, ... Afshin Beheshti ✉ + Show authors

ntific Reports **14**, Article number: 13098 (2024) | Cite this article

---

communications medicine

Explore content ˅ About the journal ˅ Publish with us ˅

nature › communications medicine › articles › article

Article | Open access | Published: 11 June 2024

Transcriptomics analysis reveals molecular alterations underpinning spaceflight dermatology

Henry Cope, Jonas Elsborg, Samuel Demharter, J. Tyson McDonald, Chiara Wernecke, Hari Parthasarathy, Hriday Unadkat, Mira Chatrathi, Jennifer Claudio, Sigrid Reinsch, Pinar Avci, Sara R. Zwart, Scott M. Smith, Martina Heer, Masafumi Muratani, Cem Meydan, Eliah Overbey, Jangkeun Kim, Christopher R. Chin, Jiwoon Park, Jonathan C. Schisler, Christopher E. Mason, Nathaniel J. Szewczyk, Craig R. G. Willis, ... Afshin Beheshti ✉ + Show authors

Communications Medicine **4**, Article number: 106 (2024) | Cite this article

---

nature communications

Explore content ˅ About the journal ˅ Publish with us ˅

nature › nature communications › articles › article

Article | Open access | Published: 11 June 2024

Spatial multi-omics of human skin reveals KRAS and inflammatory responses to spaceflight

Jiwoon Park, Eliah G. Overbey, S. Anand Narayanan, JangKeun Kim, Braden T. Tierney, Namita Damle, Deena Najjar, Krista A. Ryon, Jacqueline Proszynski, Ashley Kleinman, Jeremy Wain Hirschberg, Matthew MacKay, Evan E. Afshin, Richard Granstein, Justin Gurvitch, Briana M. Hudson, Aric Rininger, Sean Mullane, Sarah E. Church, Cem Meydan, George Church, Afshin Beheshti, Jaime Mateus & Christopher E. Mason ✉

Nature Communications **15**, Article number: 4773 (2024) | Cite this article

---

communications biology

Explore content ˅ About the journal ˅ Publish with us ˅

nature › communications biology › articles › article

Article | Open access | Published: 11 June 2024

Spaceflight induces changes in gene expression profiles linked to insulin and estrogen

Begum Aydogan Mathyk ✉, Marshall Tabetah, Rashid Karim, Victoria Zaksas, JangKeun Kim, R. I. Anu, Masafumi Muratani, Alexia Tasoula, Ruth Subhash Singh, Yen-Kai Chen, Eliah Overbey, Jiwoon Park, Henry Cope, Hossein Fazelinia, Davide Povero, Joseph Borg, Remi V. Klotz, Min Yu, Steven L. Young, Christopher E. Mason, Nathaniel Szewczyk, Riley M. St Clair, Fathi Karouia & Afshin Beheshti ✉

Communications Biology **7**, Article number: 692 (2024) | Cite this article

---

nature

Explore content ˅ About the journal ˅ Publish with us ˅

nature › perspectives › article

Perspective | Published: 11 June 2024

A Second Space Age Spanning Omics, Platforms, and Medicine Across Orbits

Christopher E. Mason ✉, James Green, Konstantinos I. Adamopoulos, Evan E. Afshin, Jordan J. Baechle, Mathias Basner, Susan M. Bailey, Luca Bielski, Josef Borg, Joseph Borg, Jared T. Broddrick, Marissa Burke, Andrés Caicedo, Verónica Castañeda, Subhamoy Chatterjee, Christopher Chin, George Church, Sylvain V. Costes, Iwijn De Vlaminck, Rajeev I. Desai, Raja Dhir, Juan Esteban Diaz, Sofia M. Etlin, Zachary Feinstein, ... Afshin Beheshti ✉ + Show authors

Nature (2024) | Cite this article

Orbit

FOUR CREW MEMBERS REPRESENTED THE MISSION PILLARS OF LEADERSHIP, HOPE, GENEROSITY, AND PROSPERITY

---

nature communications

Explore content ˅ About the journal ˅ Publish with us ˅

nature › nature communications › articles › article

Article | Open access | Published: 11 June 2024

Secretome profiling reveals acute changes in oxidative stress, brain homeostasis, and coagulation following short-duration spaceflight

Nadia Houerbi, JangKeun Kim, Eliah G. Overbey, Richa Batra, Annalise Schweickart, Laura Patras, Serena Lucotti, Krista A. Ryon, Deena Najjar, Cem Meydan, Namita Damle, Christopher Chin, S. Anand Narayanan, Joseph W. Guarnieri, Gabrielle Widjaja, Afshin Beheshti, Gabriel Tobias, Fanny Vatter
Jeremy Wain Hirschberg, Ashley Kleinman, Evan E. Afshin, Matthew MacKay, Qiuying Chen, Daw
Miller, ... Christopher E. Mason ✉ + Show authors

Nature Communications **15**, Article number: 4862 (2024) | Cite this article

---

Change 4 Astronauts' Bodies and

nature

Explore content ˅ About the journal ˅ Publish with us ˅

nature › articles › article

Article | Published: 11 June 2024

The Space Omics and Medical Atlas (SOMA) and international astronaut biobank

Eliah G. Overbey ✉, JangKeun Kim, Braden T. Tierney, Jiwoon Park, Nadia Houerbi, Alexander G. Lucaci, Sebastian Garcia Medina, Namita Damle, Deena Najjar, Kirill Grigorev, Evan E. Afshin, Krista A. Ryon, Karolina Sienkiewicz, Laura Patras, Remi Klotz, Veronica Ortiz, Matthew MacKay, Annalise Schweickart, Christopher R. Chin, Maria A. Sierra, Matias F. Valenzuela, Ezequiel Dantas, Theodore M. Nelson, Egle Cekanaviciute, ... Christopher E. Mason ✉ + Show authors

Jared Isaacman, left, and Hayley Arceneaux, two of the four Inspiration4 crew members, during the mission in 2021. SpaceX

---

nature communications

Explore content ˅ About the journal ˅ Publish with us ˅

nature › nature communications › articles › article

Article | Open access | Published: 11 June 2024

Space radiation damage rescued by inhibition of key spaceflight associated miRNAs

J. Tyson McDonald, JangKeun Kim, Lily Farmerie, Meghan L. Johnson, Nidia S. Trovao, Shehbeel Arif, Keith Siew, Sergey Tsoy, Yaron Bram, Jiwoon Park, Eliah Overbey, Krista Ryon, Jeffrey Haltom, Urminder Singh, Francisco J. Enguita, Victoria Zaksas, Joseph W. Guarnieri, Michael Topper, Douglas C. Wallace, Cem Meydan, Stephen Baylin, Robert Meller, Masafumi Muratani, D. Marshall Porterfield, ... Afshin Beheshti ✉ + Show authors

Nature Communications **15**, Article number: 4825 (2024) | Cite this article

---

nature communications

Explore content ˅ About the journal ˅ Publish with us ˅

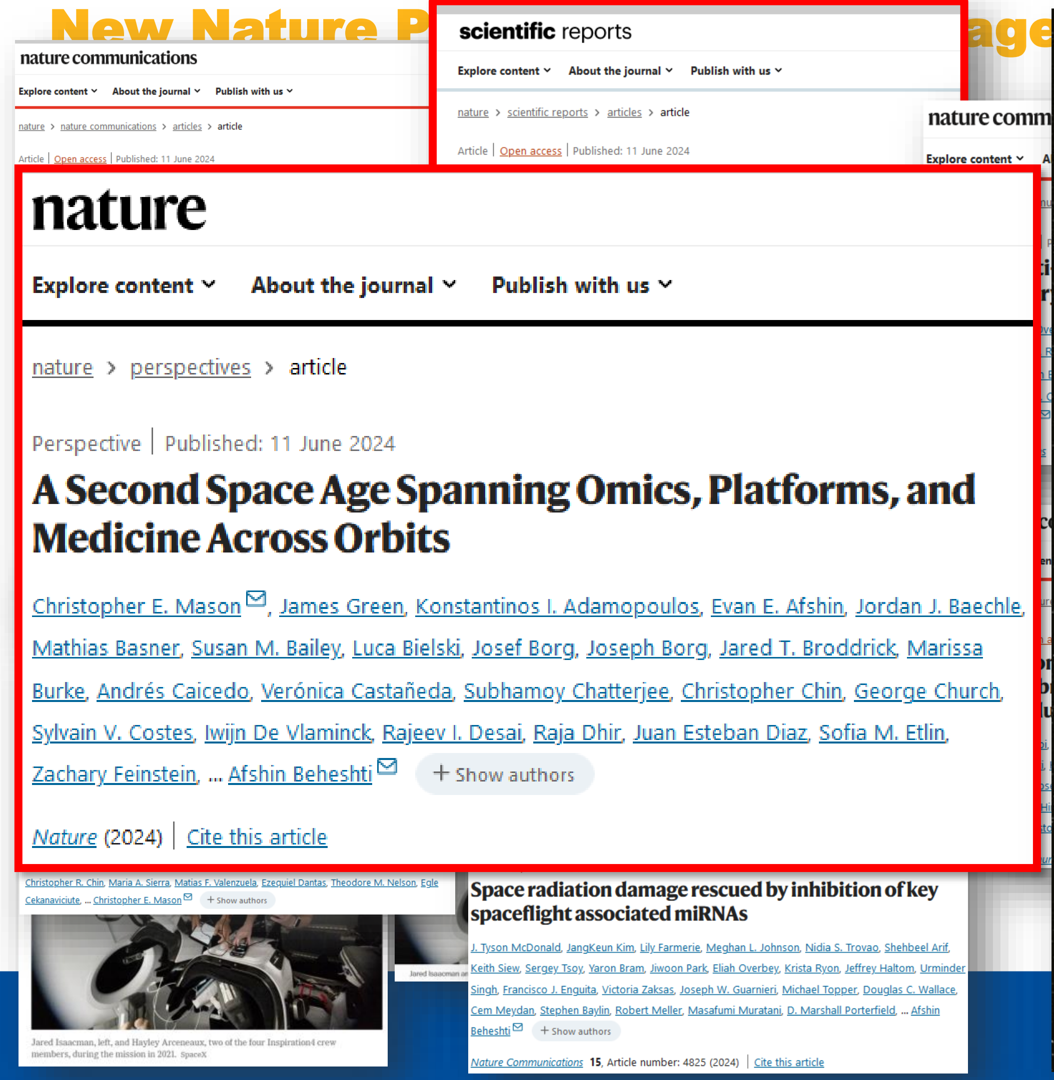
nature › nature communications › articles › article

Article | Open access | Published: 11 June 2024

Release of CD36-associated cell-free mitochondrial DNA and RNA as a hallmark of space environment response

Nailil Husna, Tatsuya Aiba, Shin-Ichiro Fujita, Yoshika Saito, Dai Shiba, Takashi Kudo, Satoru Takahashi, Satoshi Furukawa & Masafumi Muratani ✉

Nature Communications **15**, Article number: 4814 (2024) | Cite this article



nature communications

Explore content About the journal Publish with us

nature > nature communications > articles > article

Article | Open access | Published: 11 June 2024

scientific reports

Explore content About the journal Publish with us

nature > scientific reports > articles > article

Article | Open access | Published: 11 June 2024

nature

Explore content About the journal Publish with us

nature > perspectives > article

Perspective | Published: 11 June 2024

A Second Space Age Spanning Omics, Platforms, and Medicine Across Orbits

Christopher E. Mason, James Green, Konstantinos I. Adamopoulos, Evan E. Afshin, Jordan J. Baechle, Mathias Basner, Susan M. Bailey, Luca Bielski, Josef Borg, Joseph Borg, Jared T. Broddrick, Marissa Burke, Andrés Caicedo, Verónica Castañeda, Subhamoy Chatterjee, Christopher Chin, George Church, Sylvain V. Costes, Iwijn De Vlaminck, Rajeev I. Desai, Raja Dhir, Juan Esteban Diaz, Sofia M. Etlin, Zachary Feinstein, ... Afshin Beheshti + Show authors

Nature (2024) | Cite this article

Christopher R. Chin, Maria A. Sierra, Matias F. Valenzuela, Ezequiel Dantas, Theodore M. Nelson, Egle Cekanaviciute, ... Christopher E. Mason + Show authors

Jared Isaacman, left, and Hayley Arceneaux, two of the four Inspiration4 crew members, during the mission in 2021. SpaceX

Space radiation damage rescued by inhibition of key spaceflight associated miRNAs

J. Tyson McDonald, JangKeun Kim, Lily Farmerie, Meghan L. Johnson, Nidia S. Trovao, Shehbeel Arif, Keith Siew, Sergey Tsoy, Yaron Bram, Jiwoon Park, Eliah Overbey, Krista Ryon, Jeffrey Haltom, Urminder Singh, Francisco J. Enguita, Victoria Zaksas, Joseph W. Guarnieri, Michael Topper, Douglas C. Wallace, Cem Meydan, Stephen Baylin, Robert Meller, Masafumi Muratani, D. Marshall Porterfield, ... Afshin Beheshti + Show authors

Nature Communications 15, Article number: 4825 (2024) | Cite this article

The international journal of science / 29 August 2024

nature

SPACE OMICS

Biomedical atlas captures health effects of spaceflight

The Second Space Age

https://www.morganstanley.com/Themes/global-space-economy

Creating Space

Morgan Stanley believes that everyone should have an opportunity to participate in the future $1 trillion space economy. That's why we are partnering with experts in the space industry to engineer a more inclusive spacesuit of the future, which will make space exploration more accessible for female astronauts

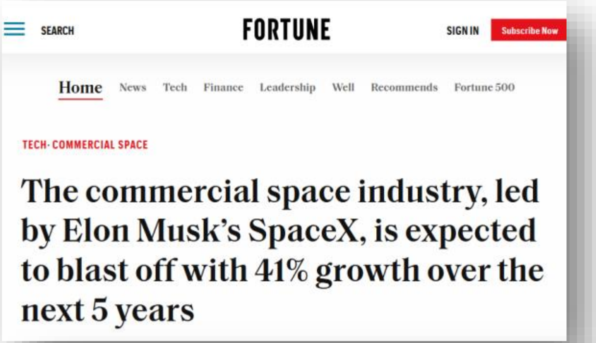
EMERGING TECHNOLOGIES

Space is booming. Here's how to embrace the $1.8 trillion opportunity

Apr 8, 2024

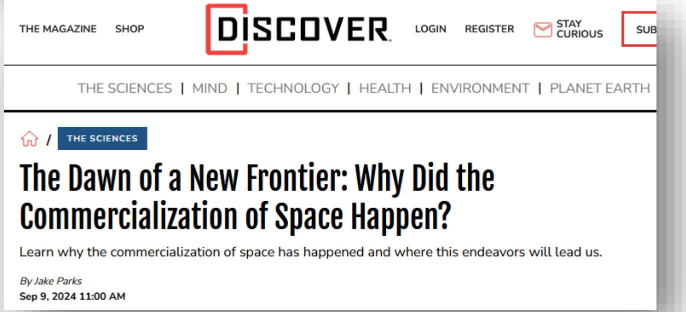
https://www.weforum.org/agenda/2024/04/space-economy-technology-invest-rocket-opportunity/

https://fortune.com/2023/07/24/space-industry-revenue-growth-five-years/



TECH · COMMERCIAL SPACE

The commercial space industry, led by Elon Musk's SpaceX, is expected to blast off with 41% growth over the next 5 years



The Dawn of a New Frontier: Why Did the Commercialization of Space Happen?

Learn why the commercialization of space has happened and where this endeavors will lead us.

By Jake Parks

Sep 9, 2024 11:00 AM

https://www.discovermagazine.com/the-sciences/the-dawn-of-a-new-frontier-why-did-the-commercialization-of-space-happen

Question:

Can we leverage other publicly available data platforms to determine novel hypothesis and data for advancing both clinical and spaceflight related issues?

Question: Can we leverage multiple publicly available data platforms to determine novel hypothesis and data for advancing both clinical and spaceflight related issues?

Short Answer: Yes!!

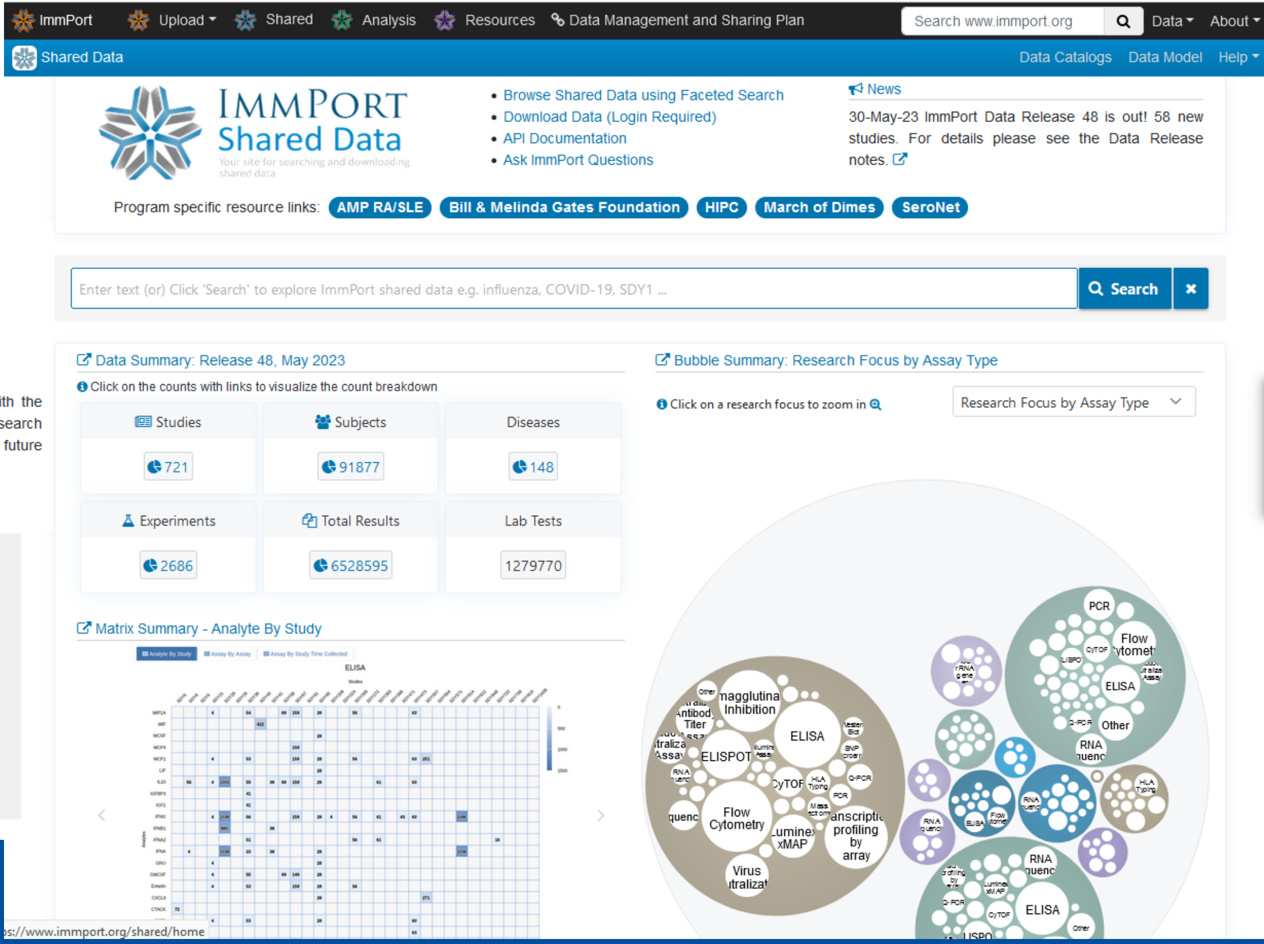
www.immport.org

IMMPORT
BIOINFORMATICS FOR THE FUTURE OF IMMUNOLOGY

ImmPort is funded by the NIH, NIAID and DAIT in support of the NIH mission to share data with the public. Data shared through ImmPort has been provided by NIH-funded programs, other research organizations and individual scientists ensuring these discoveries will be the foundation of future research.

Data uploading or sharing questions? Please contact ImmPort_Helpdesk@immport.org.

University of Pittsburgh



- Browse Shared Data using Faceted Search
- Download Data (Login Required)
- API Documentation
- Ask ImmPort Questions

News

30-May-23 ImmPort Data Release 48 is out! 58 new studies. For details please see the Data Release notes.

Program specific resource links: AMP RA/SLE | Bill & Melinda Gates Foundation | HIPC | March of Dimes | SeroNet

Enter text (or) Click 'Search' to explore ImmPort shared data e.g. influenza, COVID-19, SDY1 ... | Search

Data Summary: Release 48, May 2023

Click on the counts with links to visualize the count breakdown

Studies	Subjects	Diseases
721	91877	148
Experiments	**Total Results**	**Lab Tests**
2686	6528595	1279770

Bubble Summary: Research Focus by Assay Type

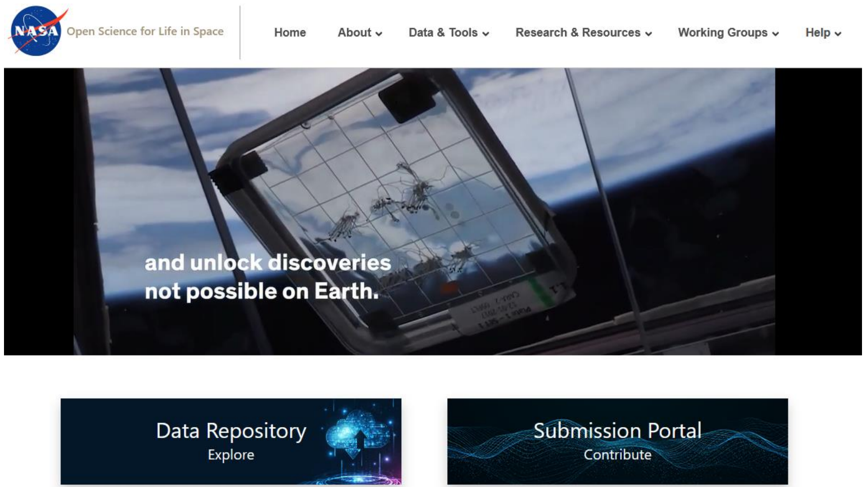
Click on a research focus to zoom in

Research Focus by Assay Type

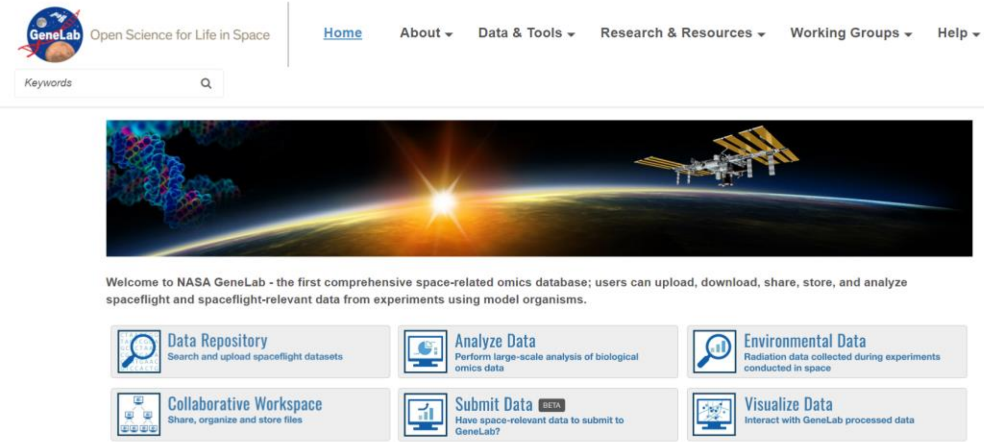
Matrix Summary - Analyte By Study

s://www.immport.org/shared/home

Space Omics Platform that The Public can Use!!



https://osdr.nasa.gov



Welcome to NASA GeneLab - the first comprehensive space-related omics database; users can upload, download, share, store, and analyze spaceflight and spaceflight-relevant data from experiments using model organisms.

Data Repository
Search and upload spaceflight datasets

Analyze Data
Perform large-scale analysis of biological omics data

Environmental Data
Radiation data collected during experiments conducted in space

Collaborative Workspace
Share, organize and store files

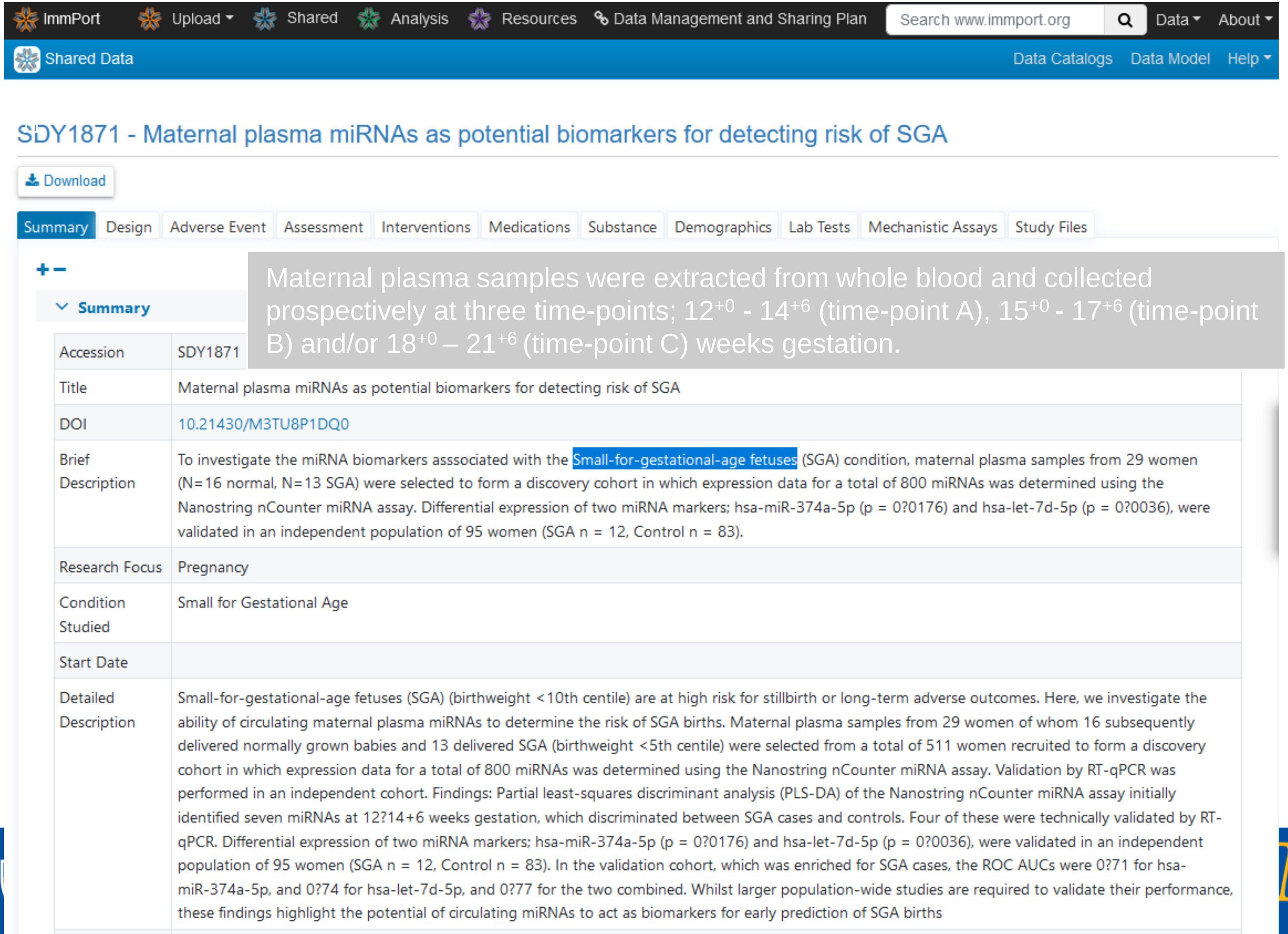
Submit Data
Have space-relevant data to submit to GeneLab?

Visualize Data
Interact with GeneLab processed data

GeneLab (genelab.nasa.gov)

Dataset on ImmPort Related to Small-for-gestational-age fetuses (SGA)

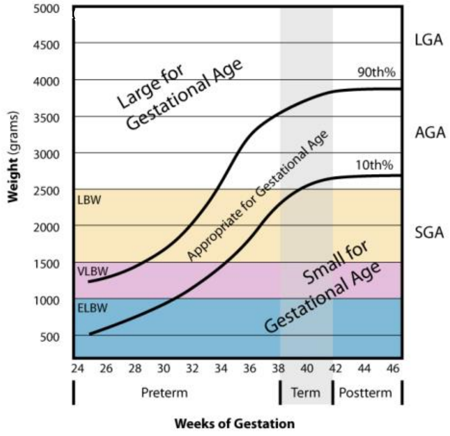
Maternal plasma samples were extracted from whole blood and collected prospectively at three time-points; 12^{+0} - 14^{+6} (time-point A), 15^{+0} - 17^{+6} (time-point B) and/or 18^{+0} – 21^{+6} (time-point C) weeks gestation.



SDY1871 - Maternal plasma miRNAs as potential biomarkers for detecting risk of SGA

Summary

Accession	SDY1871
Title	Maternal plasma miRNAs as potential biomarkers for detecting risk of SGA
DOI	10.21430/M3TU8P1DQ0
Brief Description	To investigate the miRNA biomarkers asssociated with the Small-for-gestational-age fetuses (SGA) condition, maternal plasma samples from 29 women (N=16 normal, N=13 SGA) were selected to form a discovery cohort in which expression data for a total of 800 miRNAs was determined using the Nanostring nCounter miRNA assay. Differential expression of two miRNA markers; hsa-miR-374a-5p (p = 0?0176) and hsa-let-7d-5p (p = 0?0036), were validated in an independent population of 95 women (SGA n = 12, Control n = 83).
Research Focus	Pregnancy
Condition Studied	Small for Gestational Age
Start Date	
Detailed Description	Small-for-gestational-age fetuses (SGA) (birthweight <10th centile) are at high risk for stillbirth or long-term adverse outcomes. Here, we investigate the ability of circulating maternal plasma miRNAs to determine the risk of SGA births. Maternal plasma samples from 29 women of whom 16 subsequently delivered normally grown babies and 13 delivered SGA (birthweight <5th centile) were selected from a total of 511 women recruited to form a discovery cohort in which expression data for a total of 800 miRNAs was determined using the Nanostring nCounter miRNA assay. Validation by RT-qPCR was performed in an independent cohort. Findings: Partial least-squares discriminant analysis (PLS-DA) of the Nanostring nCounter miRNA assay initially identified seven miRNAs at 12?14+6 weeks gestation, which discriminated between SGA cases and controls. Four of these were technically validated by RT-qPCR. Differential expression of two miRNA markers; hsa-miR-374a-5p (p = 0?0176) and hsa-let-7d-5p (p = 0?0036), were validated in an independent population of 95 women (SGA n = 12, Control n = 83). In the validation cohort, which was enriched for SGA cases, the ROC AUCs were 0?71 for hsa-miR-374a-5p, and 0?74 for hsa-let-7d-5p, and 0?77 for the two combined. Whilst larger population-wide studies are required to validate their performance, these findings highlight the potential of circulating miRNAs to act as biomarkers for early prediction of SGA births



EBioMedicine 62 (2020) 103145

Contents lists available at ScienceDirect

EBioMedicine

journal homepage: www.elsevier.com/locate/ebiom

Research paper

Maternal plasma miRNAs as potential biomarkers for detecting risk of small-for-gestational-age births

Sung Hye Kim[a,b], David A. MacIntyre[a,b], Reem Binkhamis[a], Joanna Cook[a,c,d], Lynne Sykes[a,b,c], Phillip R. Bennett[a,b,c], Vasso Terzidou[a,b,c,e,*]

[a] Parturition Group, Department of Metabolism, Digestion and Reproduction, Imperial College London, Institute of Reproductive and Developmental Biology, Du Cane Road, London W12 0NN, United Kingdom
[b] March of Dimes European Preterm Birth Research Centre, Imperial College London, United Kingdom
[c] Queen Charlotte's and Chelsea Hospital, Imperial College Healthcare NHS Trust, London, United Kingdom
[d] St. Mary's Hospital, Imperial College Healthcare NHS Trust, London, United Kingdom
[e] Academic Department of Obstetrics and Gynaecology, Chelsea and Westminster Hospital, London, United Kingdom

A R T I C L E I N F O

Article History:
Received 28 August 2020
Revised 2 November 2020
Accepted 11 November 2020
Available online xxx

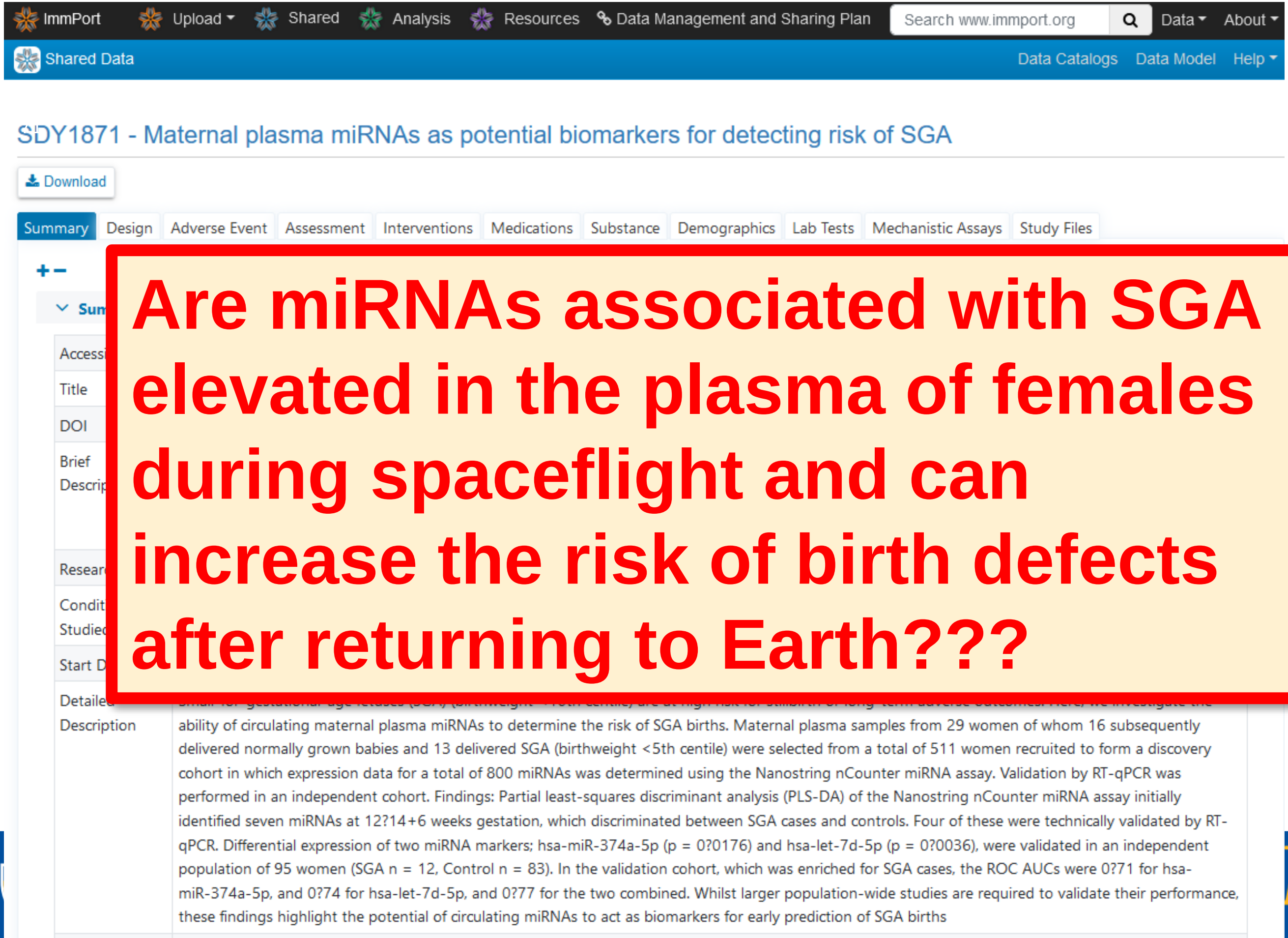
Keywords:
MiRNA
Biomarker
Plasma
Small-for-gestational-age

A B S T R A C T

Background: Small-for-gestational-age fetuses (SGA) (birthweight <10th centile) are at high risk for stillbirth or long-term adverse outcomes. Here, we investigate the ability of circulating maternal plasma miRNAs to determine the risk of SGA births.
Methods: Maternal plasma samples from 29 women of whom 16 subsequently delivered normally grown babies and 13 delivered SGA (birthweight <5th centile) were selected from a total of 511 women recruited to form a discovery cohort in which expression data for a total of 800 miRNAs was determined using the Nanostring nCounter miRNA assay. Validation by RT-qPCR was performed in an independent cohort.
Findings: Partial least-squares discriminant analysis (PLS-DA) of the Nanostring nCounter miRNA assay initially identified seven miRNAs at 12–14^{+6} weeks gestation, which discriminated between SGA cases and controls. Four of these were technically validated by RT-qPCR. Differential expression of two miRNA markers; hsa-miR-374a-5p (p = 0•0176) and hsa-let-7d-5p (p = 0•0036), were validated in an independent population of 95 women (SGA n = 12, Control n = 83). In the validation cohort, which was enriched for SGA cases, the ROC AUCs were 0•71 for hsa-miR-374a-5p, and 0•74 for hsa-let-7d-5p, and 0•77 for the two combined.
Interpretation: Whilst larger population-wide studies are required to validate their performance, these findings highlight the potential of circulating miRNAs to act as biomarkers for early prediction of SGA births.
Funding: This work was supported by Genesis Research Trust, March of Dimes, and the National Institute for Health Research Biomedical Research Centre (NIHR BRC) based at Imperial Healthcare NHS Trust and Imperial College London.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7708817/pdf/main.p

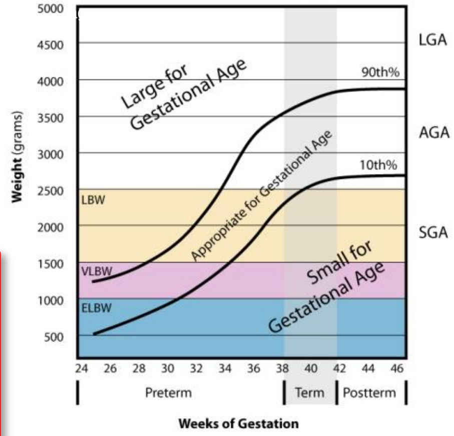
Dataset on ImmPort Related to Small-for-gestational-age fetuses (SGA)



SDY1871 - Maternal plasma miRNAs as potential biomarkers for detecting risk of SGA

Access	
Title	
DOI	
Brief Descrip	
Resear	
Condit Studie	
Start D	
Detailed Description	ability of circulating maternal plasma miRNAs to determine the risk of SGA births. Maternal plasma samples from 29 women of whom 16 subsequently delivered normally grown babies and 13 delivered SGA (birthweight <5th centile) were selected from a total of 511 women recruited to form a discovery cohort in which expression data for a total of 800 miRNAs was determined using the Nanostring nCounter miRNA assay. Validation by RT-qPCR was performed in an independent cohort. Findings: Partial least-squares discriminant analysis (PLS-DA) of the Nanostring nCounter miRNA assay initially identified seven miRNAs at 12?14+6 weeks gestation, which discriminated between SGA cases and controls. Four of these were technically validated by RT-qPCR. Differential expression of two miRNA markers; hsa-miR-374a-5p (p = 0?0176) and hsa-let-7d-5p (p = 0?0036), were validated in an independent population of 95 women (SGA n = 12, Control n = 83). In the validation cohort, which was enriched for SGA cases, the ROC AUCs were 0?71 for hsa-miR-374a-5p, and 0?74 for hsa-let-7d-5p, and 0?77 for the two combined. Whilst larger population-wide studies are required to validate their performance, these findings highlight the potential of circulating miRNAs to act as biomarkers for early prediction of SGA births

Are miRNAs associated with SGA elevated in the plasma of females during spaceflight and can increase the risk of birth defects after returning to Earth???



EBioMedicine 62 (2020) 103145

Contents lists available at ScienceDirect

EBioMedicine

journal homepage: www.elsevier.com/locate/ebiom

paper

nal plasma miRNAs as potential biomarkers for detecting risk of for-gestational-age births

e Kim[a,b], David A. MacIntyre[a,b], Reem Binkhamis[a], Joanna Cook[a,c,d], Lynne Sykes[a,b,c], . Bennett[a,b,c], Vasso Terzidou[a,b,c,e,*]

roup, Department of Metabolism, Digestion and Reproduction, Imperial College London, Institute of Reproductive and Developmental Biology, Du
ndon W12 0NN, United Kingdom
nes European Preterm Birth Research Centre, Imperial College London, United Kingdom
otte's and Chelsea Hospital, Imperial College Healthcare NHS Trust, London, United Kingdom
spital, Imperial College Healthcare NHS Trust, London, United Kingdom
partment of Obstetrics and Gynaecology, Chelsea and Westminster Hospital, London, United Kingdom

ARTICLE INFO

Article History:
Received 28 August 2020
Revised 2 November 2020
Accepted 11 November 2020
Available online xxx

Keywords:
MiRNA
Biomarker
Plasma
Small-for-gestational-age

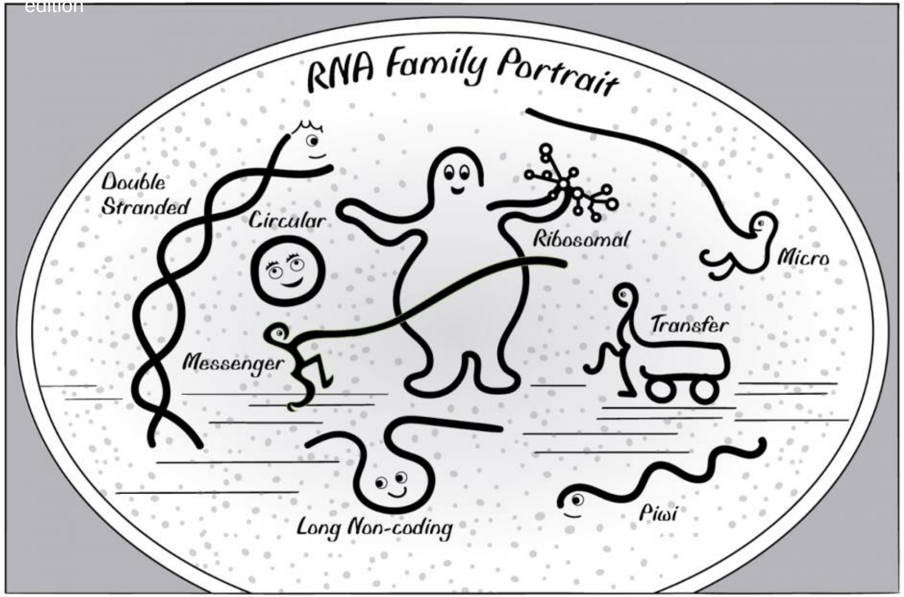
ABSTRACT

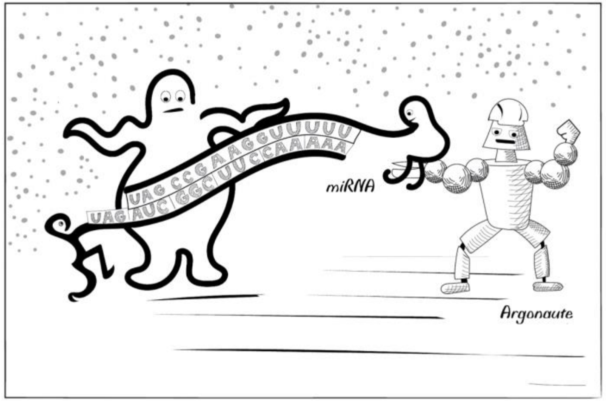
Background: Small-for-gestational-age fetuses (SGA) (birthweight <10th centile) are at high risk for stillbirth or long-term adverse outcomes. Here, we investigate the ability of circulating maternal plasma miRNAs to determine the risk of SGA births.
Methods: Maternal plasma samples from 29 women of whom 16 subsequently delivered normally grown babies and 13 delivered SGA (birthweight <5th centile) were selected from a total of 511 women recruited to form a discovery cohort in which expression data for a total of 800 miRNAs was determined using the Nanostring nCounter miRNA assay. Validation by RT-qPCR was performed in an independent cohort.
Findings: Partial least-squares discriminant analysis (PLS-DA) of the Nanostring nCounter miRNA assay initially identified seven miRNAs at 12–14^{+6} weeks gestation, which discriminated between SGA cases and controls. Four of these were technically validated by RT-qPCR. Differential expression of two miRNA markers; hsa-miR-374a-5p (p = 0•0176) and hsa-let-7d-5p (p = 0•0036), were validated in an independent population of 95 women (SGA n = 12, Control n = 83). In the validation cohort, which was enriched for SGA cases, the ROC AUCs were 0•71 for hsa-miR-374a-5p, and 0•74 for hsa-let-7d-5p, and 0•77 for the two combined.
Interpretation: Whilst larger population-wide studies are required to validate their performance, these findings highlight the potential of circulating miRNAs to act as biomarkers for early prediction of SGA births.
Funding: This work was supported by Genesis Research Trust, March of Dimes, and the National Institute for Health Research Biomedical Research Centre (NIHR BRC) based at Imperial Healthcare NHS Trust and Imperial College London.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7708817/pdf/main.p

What are microRNAs (miRNAs)?

edition





- MicroRNAs (miRNAs) are one of the many types of RNAs that don’t code for proteins.
- Instead, they target and bind to sequences in specific mRNAs (i.e. genes) and can block the mRNA from being translated.
- MiRNAs don’t travel alone: they pair up with a large protein called Argonaute, which protects them from destructive enzymes called nucleases in the cell.
    - Because of this protective protein, miRNAs can live in the cell for up to a week, floating around and targeting mRNAs for degradation.

What are miRNAs and why study miRNAs?

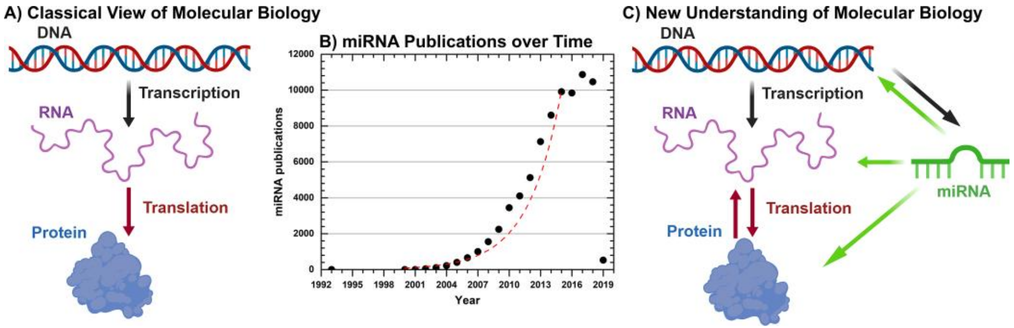
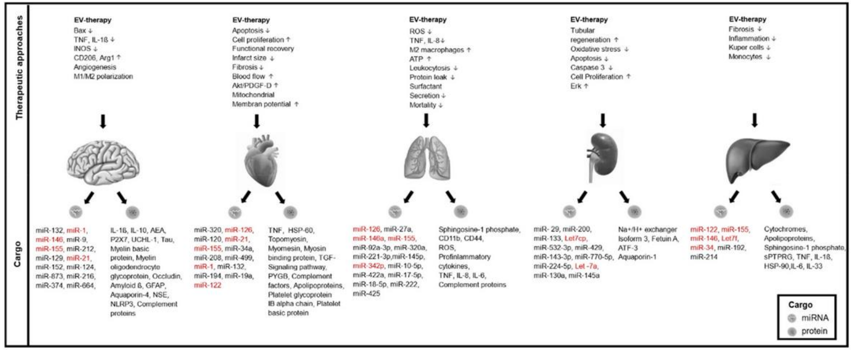


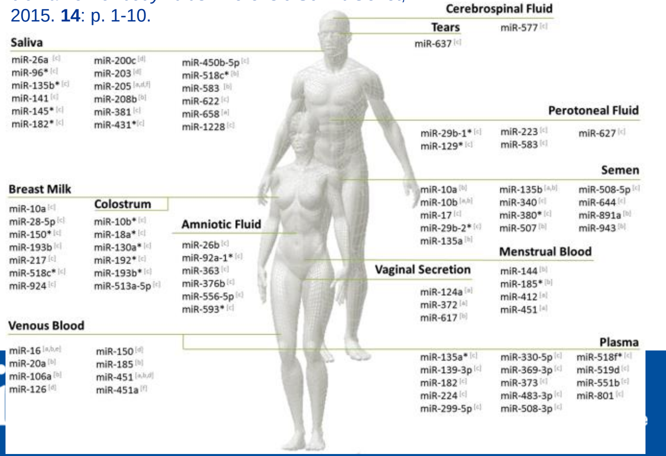
Figure from Vanderburg and Beheshti, MicroRNAs (miRNAs), the Final Frontier: The Hidden Master Regulators Impacting Biological Response in All Organisms Due to Spaceflight, THREE, 2020. (https://three.jsc.nasa.gov/Encyclopedia/Article/80)

Weber, B., Franz, N., Marzi, I. *et al.* Extracellular vesicles as mediators and markers of acute organ injury: current concepts. *Eur J Trauma Emerg Surg* **48**, 1525–1544 (2022). https://doi.org/10.1007/s00068-021-01607-1

From: Extracellular vesicles as mediators and markers of acute organ injury: current concepts



Silva, S.S., et al., *Forensic miRNA: potential biomarker for body fluids?* Forensic Sci Int Genet, 2015. **14**: p. 1-10.



- **A single miRNA can regulate 100s to 1000s of mRNAs.**
- **miRNAs are ~22nt**
- **Due to the size and stability of the miRNAs, it can float freely in the blood.**
- **miRNAs are now known to be involved in all aspects of diseases.**
- **miRNA are not only found in mammals, but everything else living: plants, microbes, fish, C. Elegans, fruit flies, insects, etc…**
- **miRNAs are highly conserved across species.**
- ***miRNAs can be good biomarkers and therapeutic targets for many diseases***

What are m s?

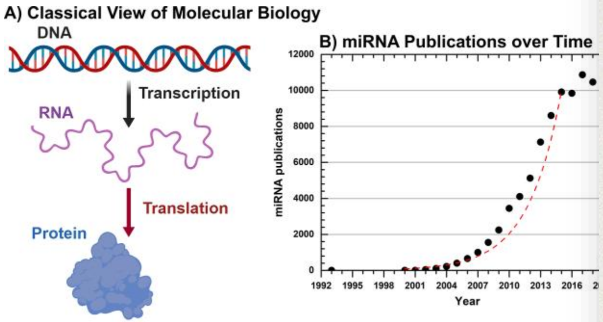
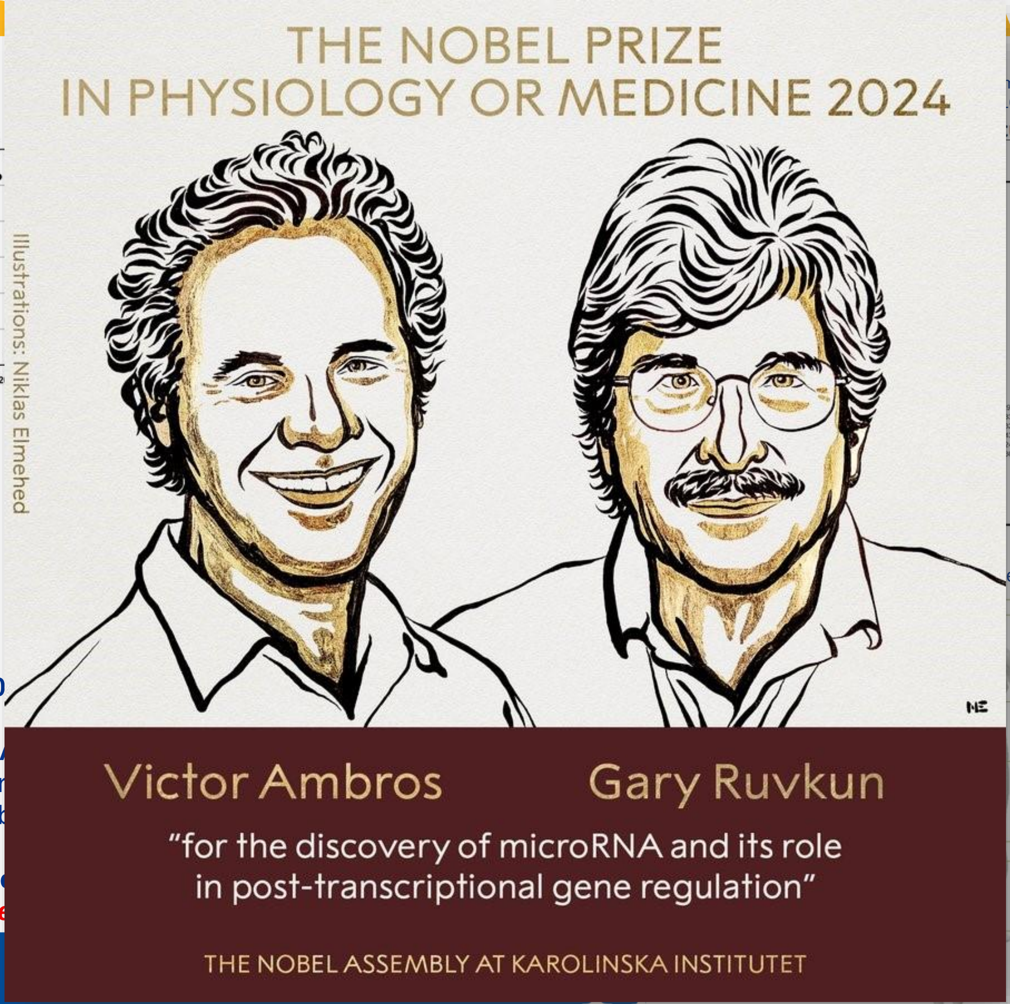


Figure from Vanderburg and Beheshti, MicroRNAs (miRNAs), the Final Frontier: The Hidden Master Regulators Impacting Biological Response in All Organisms Due to Spaceflight, THREE, 2020. (https://three.jsc.nasa.gov/Encyclopedia/Article/80)

- A single miRNA can regulate 100s to 100
- miRNAs are ~22nt
- Due to the size and stability of the miRN
- miRNAs are now known to be involved i
- miRNA are not only found in mammals, b C. Elegans, fruit flies, insects, etc…
- miRNAs are highly conserved across sp
- *miRNAs can be good biomarkers and the*



THE NOBEL PRIZE
IN PHYSIOLOGY OR MEDICINE 2024

Illustrations: Niklas Elmehed

NE

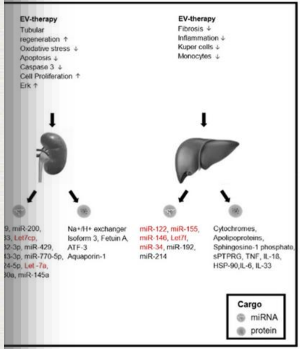
Victor Ambros **Gary Ruvkun**

"for the discovery of microRNA and its role in post-transcriptional gene regulation"

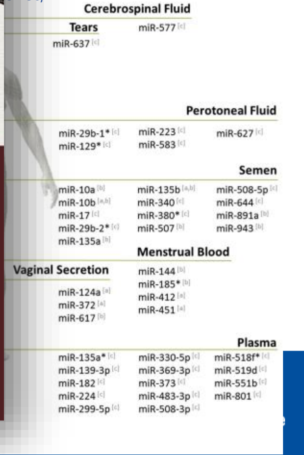
THE NOBEL ASSEMBLY AT KAROLINSKA INSTITUTET

markers of acute organ injury: current
.0.1007/s00068-021-01607-1

ute organ injury: current



enet,



Systems Biology View of miRNAs

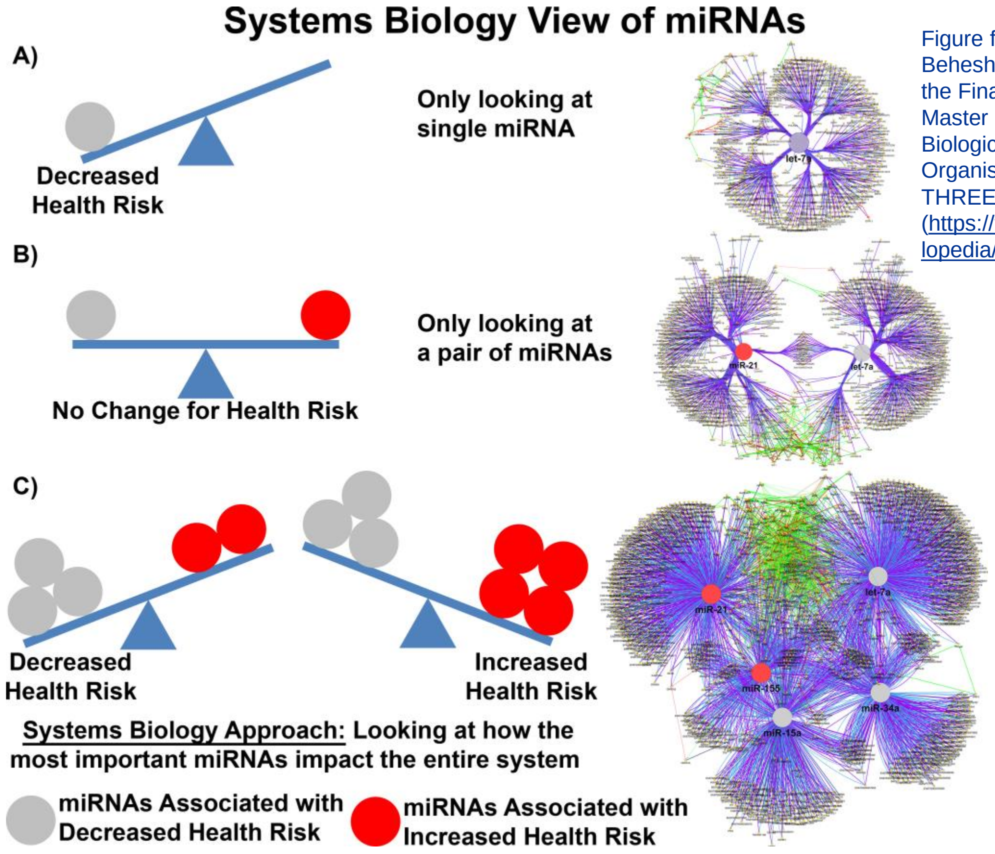
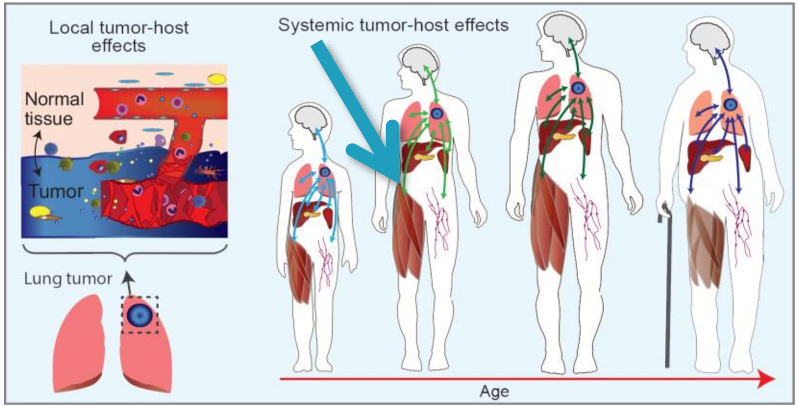


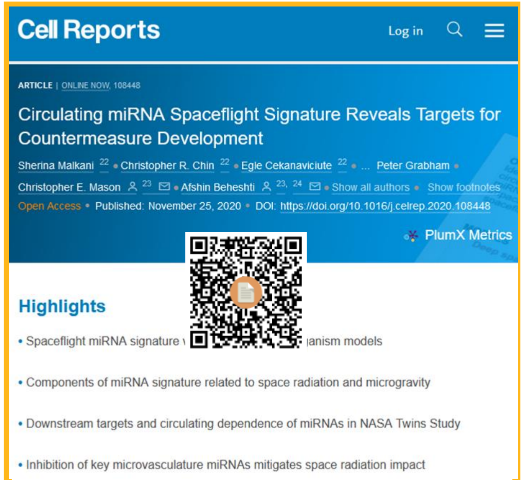
Figure from Vanderburg and Beheshti, MicroRNAs (miRNAs), the Final Frontier: The Hidden Master Regulators Impacting Biological Response in All Organisms Due to Spaceflight, THREE, 2020. (https://three.jsc.nasa.gov/Encyclopedia/Article/80)

Circulating miRNAs



Beheshti, et al. Oncotarget 2015

miRNAs and Space: What I have done so far!



Cell Reports
Log in

ARTICLE | ONLINE NOW, 108448

Circulating miRNA Spaceflight Signature Reveals Targets for Countermeasure Development

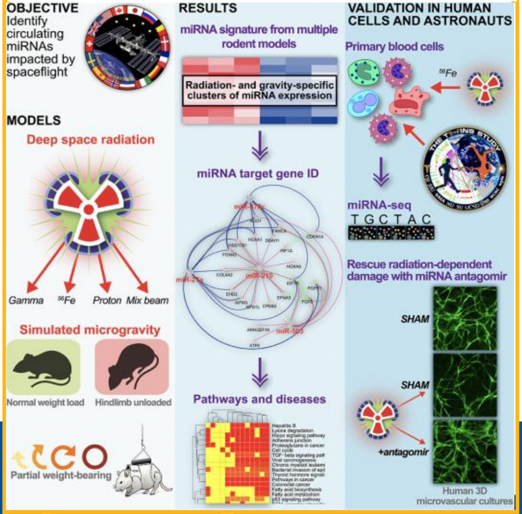
Sherina Malkani [22] • Christopher R. Chin [22] • Egle Cekanaviciute [22] • … Peter Grabham • Christopher E. Mason [23] • Afshin Beheshti [23, 24] • Show all authors • Show footnotes

Open Access • Published: November 25, 2020 • DOI: https://doi.org/10.1016/j.celrep.2020.108448

PlumX Metrics

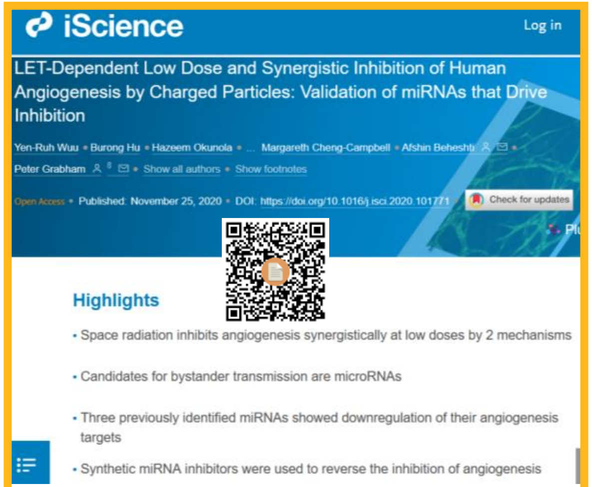
Highlights

- Spaceflight miRNA signature \ janism models
- Components of miRNA signature related to space radiation and microgravity
- Downstream targets and circulating dependence of miRNAs in NASA Twins Study
- Inhibition of key microvasculature miRNAs mitigates space radiation impact



Peter Grabham

Columbia University Irving Medical Center



iScience
Log in

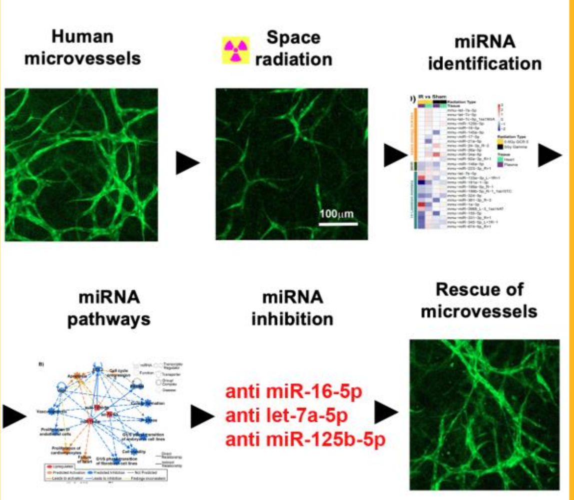
LET-Dependent Low Dose and Synergistic Inhibition of Human Angiogenesis by Charged Particles: Validation of miRNAs that Drive Inhibition

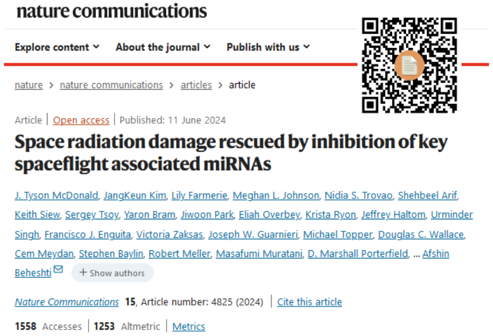
Yen-Ruh Wuu • Burong Hu • Hazeem Okunola • … Margareth Cheng-Campbell • Afshin Beheshti • Peter Grabham [8] • Show all authors • Show footnotes

Open Access • Published: November 25, 2020 • DOI: https://doi.org/10.1016/j.isci.2020.101771 • Check for updates

Highlights

- Space radiation inhibits angiogenesis synergistically at low doses by 2 mechanisms
- Candidates for bystander transmission are microRNAs
- Three previously identified miRNAs showed downregulation of their angiogenesis targets
- Synthetic miRNA inhibitors were used to reverse the inhibition of angiogenesis





nature communications

Explore content ˅ About the journal ˅ Publish with us ˅

nature › nature communications › articles › article

Article | Open access | Published: 11 June 2024

Space radiation damage rescued by inhibition of key spaceflight associated miRNAs

J. Tyson McDonald, JangKeun Kim, Lily Farmerie, Meghan L. Johnson, Nidia S. Trovao, Shehbeel Arif, Keith Siew, Sergey Tsoy, Yaron Bram, Jiwoon Park, Eliah Overbey, Krista Ryon, Jeffrey Haltom, Urminder Singh, Francisco J. Enguita, Victoria Zaksas, Joseph W. Guarnieri, Michael Topper, Douglas C. Wallace, Cem Meydan, Stephen Baylin, Robert Meller, Masafumi Muratani, D. Marshall Porterfield, … Afshin Beheshti + Show authors

Nature Communications **15**, Article number: 4825 (2024) | Cite this article

1558 Accesses | **1253** Altmetric | Metrics

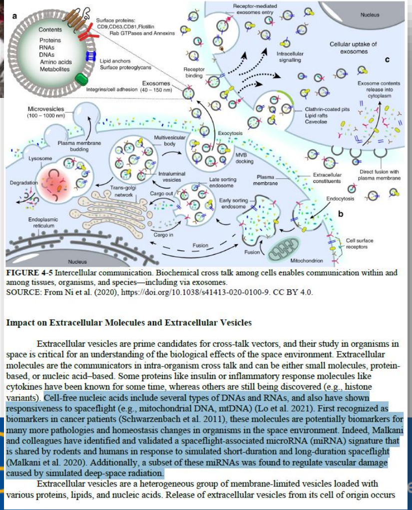


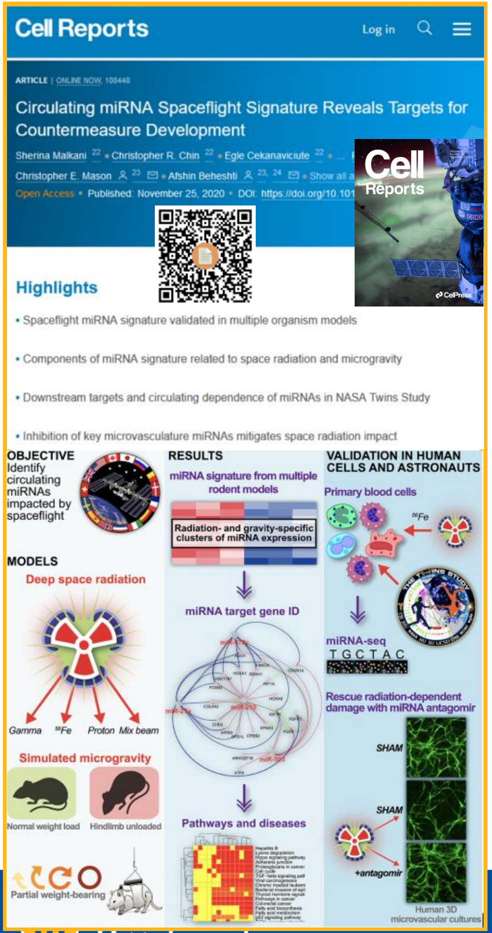
FIGURE 4-5 Intercellular communication. Biochemical cross talk among cells enables communication within and among tissues, organisms, and species—including via exosomes.
SOURCE: From Ni et al. (2020), https://doi.org/10.1038/s41413-020-0100-9. CC BY 4.0.

Impact on Extracellular Molecules and Extracellular Vesicles

Extracellular vesicles are prime candidates for cross-talk vectors, and their study in organisms in space is critical for an understanding of the biological effects of the space environment. Extracellular molecules are the communicators in intra-organism cross talk and can be either small molecules, protein-based, or nucleic acid–based. Some proteins like insulin or inflammatory response molecules like cytokines have been known for some time, whereas others are still being discovered (e.g., histone variants). Cell-free nucleic acids include several types of DNAs and RNAs, and also have shown responsiveness to spaceflight (e.g., mitochondrial DNA, mtDNA) (Lo et al. 2021). First recognized as biomarkers in cancer patients (Schwarzenbach et al. 2011), these molecules are potentially biomarkers for many more pathologies and homeostasis changes in organisms in the space environment. Indeed, Malkani and colleagues have identified and validated a spaceflight-associated microRNA (miRNA) signature that is shared by rodents and humans in response to simulated short-duration and long-duration spaceflight (Malkani et al. 2020). Additionally, a subset of these miRNAs was found to regulate vascular damage caused by simulated deep-space radiation.

Extracellular vesicles are a heterogeneous group of membrane-limited vesicles loaded with various proteins, lipids, and nucleic acids. Release of extracellular vesicles from its cell of origin occurs

miRNAs and Space: What I have done so far!



Cell Reports Log in

ARTICLE | ONLINE NOW, 108448

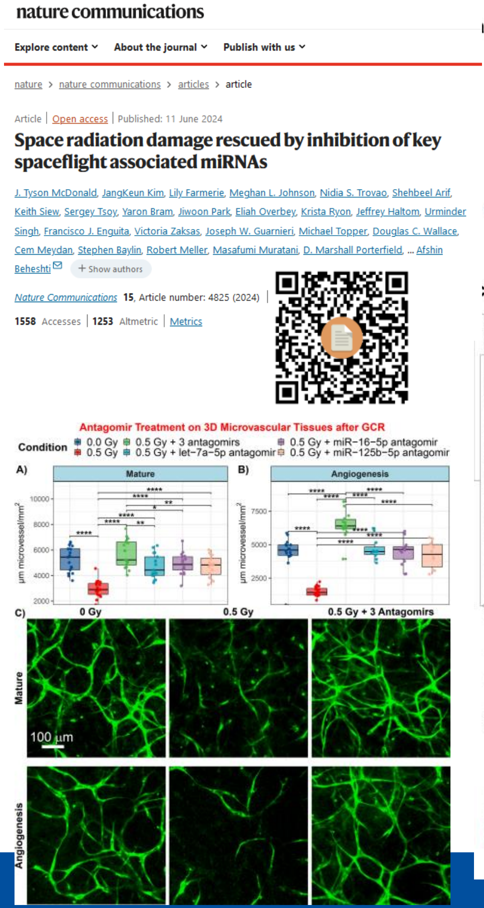
Circulating miRNA Spaceflight Signature Reveals Targets for Countermeasure Development

Sherina Malkani [22] • Christopher R. Chin [22] • Egle Cekanaviciute [22] • … Christopher E. Mason [23] • Afshin Beheshti [23, 24] • Show all a

Open Access • Published: November 25, 2020 • DOI: https://doi.org/10.101

Highlights

- 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 Twins Study
- Inhibition of key microvasculature miRNAs mitigates space radiation impact



nature communications

Explore content ⌄ About the journal ⌄ Publish with us ⌄

nature › nature communications › articles › article

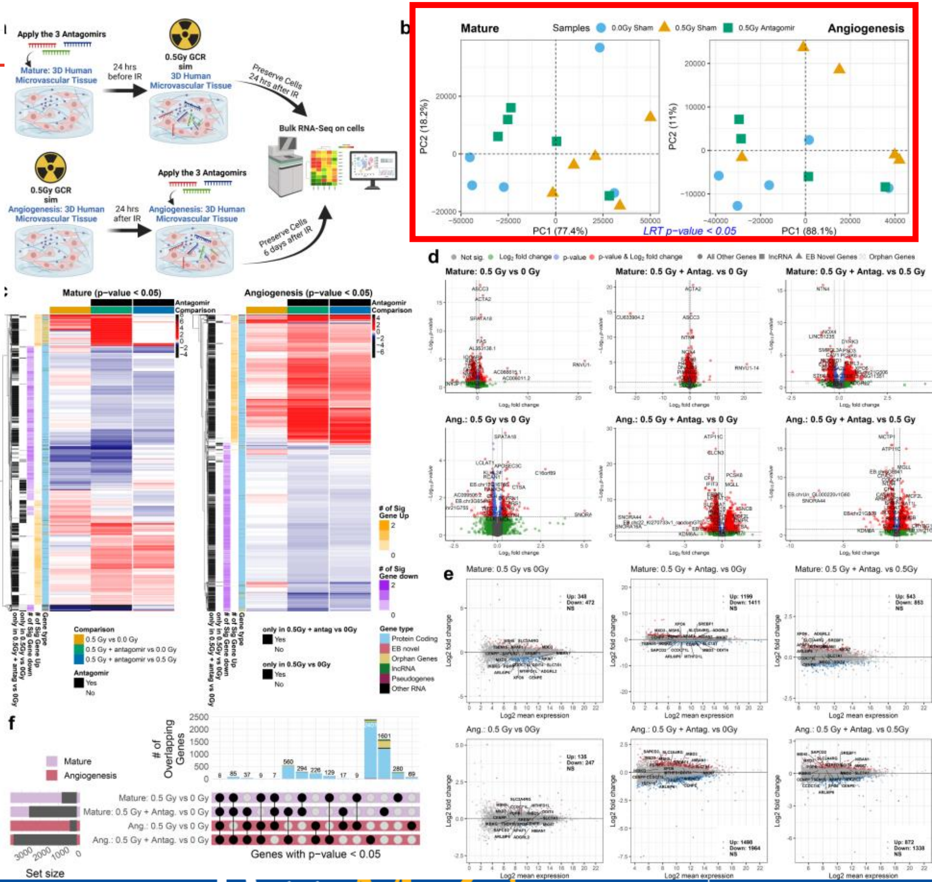
Article | Open access | Published: 11 June 2024

Space radiation damage rescued by inhibition of key spaceflight associated miRNAs

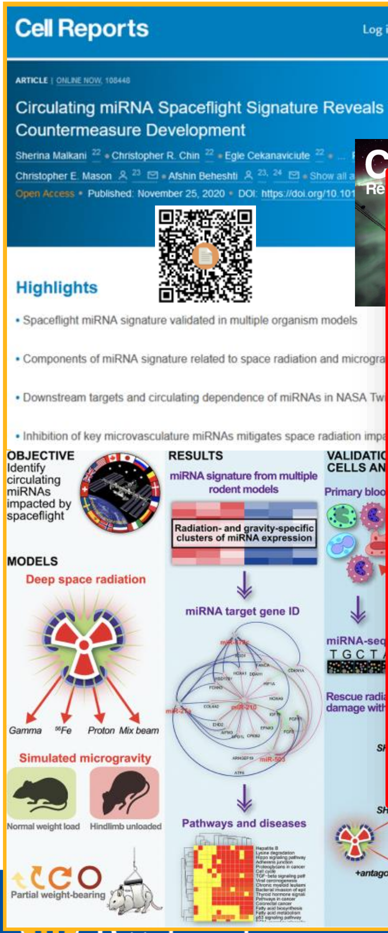
J. Tyson McDonald, JangKeun Kim, Lily Farmerie, Meghan L. Johnson, Nidia S. Trovao, Shehbeel Arif, Keith Siew, Sergey Tsoy, Yaron Bram, Jiwoon Park, Eliah Overbey, Krista Ryon, Jeffrey Haltom, Urminder Singh, Francisco J. Enguita, Victoria Zaksas, Joseph W. Guarnieri, Michael Topper, Douglas C. Wallace, Cem Meydan, Stephen Baylin, Robert Meller, Masafumi Muratani, D. Marshall Porterfield, ... Afshin Beheshti + Show authors

Nature Communications **15**, Article number: 4825 (2024)

1558 Accesses | **1253** Altmetric | Metrics



miRNAs and Space: What I have done so far!



Cell Reports Log in

ARTICLE | ONLINE NOW, 108448

Circulating miRNA Spaceflight Signature Reveals Targets for Countermeasure Development

Sherina Malkani [22] • Christopher R. Chin [22] • Egle Cekanaviciute [22] • … Christopher E. Mason [23] • Afshin Beheshti [23, 24] • Show all a

Open Access • Published: November 25, 2020 • DOI: https://doi.org/10.101

Highlights

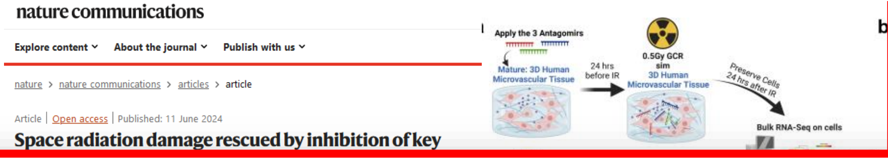
- Spaceflight miRNA signature validated in multiple organism models
- Components of miRNA signature related to space radiation and micrograv
- Downstream targets and circulating dependence of miRNAs in NASA Tw
- Inhibition of key microvasculature miRNAs mitigates space radiation impa

OBJECTIVE
Identify circulating miRNAs impacted by spaceflight

MODELS
Deep space radiation
Gamma ⁵⁶Fe Proton Mix beam
Simulated microgravity
Normal weight load Hindlimb unloaded
Partial weight-bearing

RESULTS
miRNA signature from multiple rodent models
Radiation- and gravity-specific clusters of miRNA expression
miRNA target gene ID
Pathways and diseases

VALIDATIO CELLS AN
Primary bloo
miRNA-seq
Rescue radia damage with
SHAM
+antagomir
Human 3D microvascular cultures



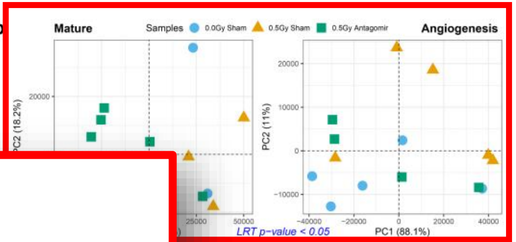
nature communications

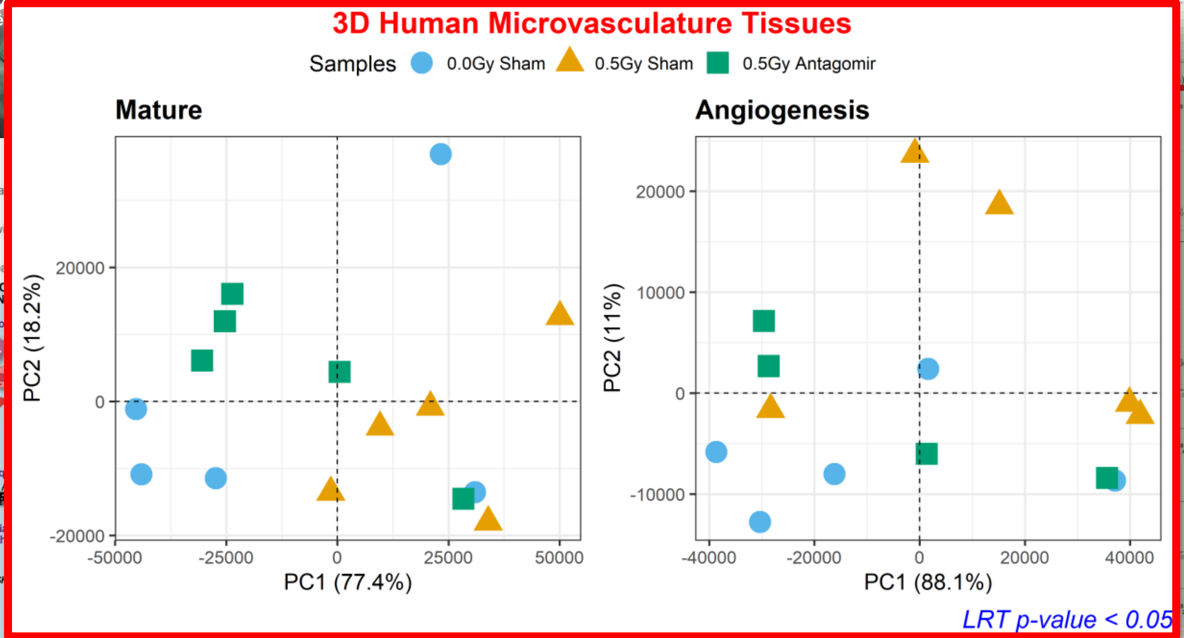
Explore content ⌄ About the journal ⌄ Publish with us ⌄

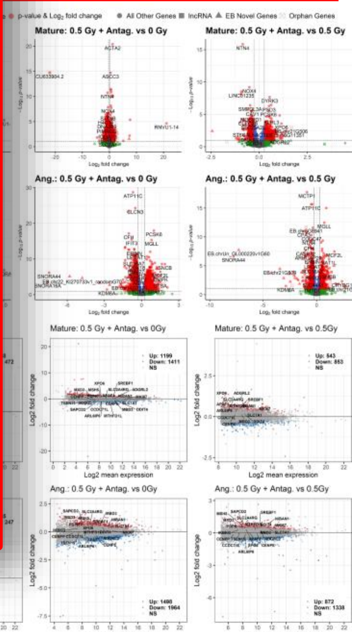
nature > nature communications > articles > article

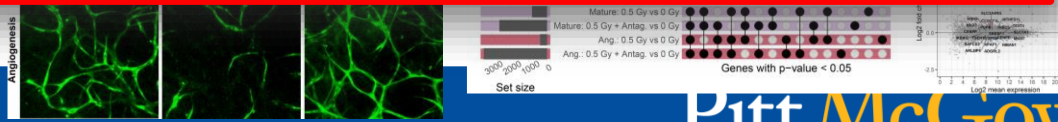
Article | Open access | Published: 11 June 2024

Space radiation damage rescued by inhibition of key

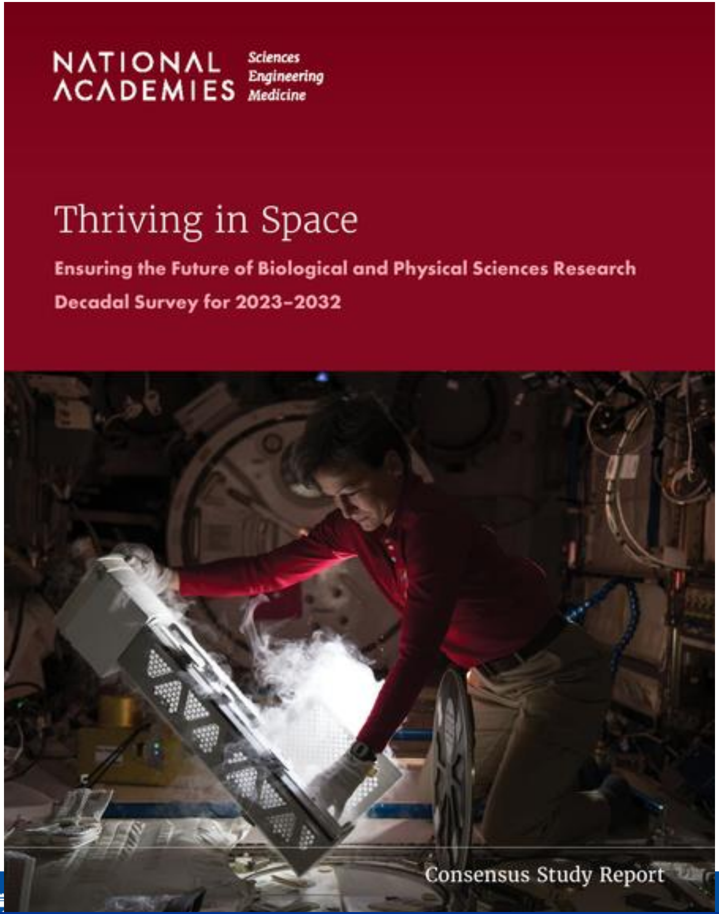








miRNAs Important Focus for Space Research in the next 10 years!!!



NATIONAL ACADEMIES *Sciences Engineering Medicine*

Thriving in Space

Ensuring the Future of Biological and Physical Sciences Research

Decadal Survey for 2023–2032

Consensus Study Report

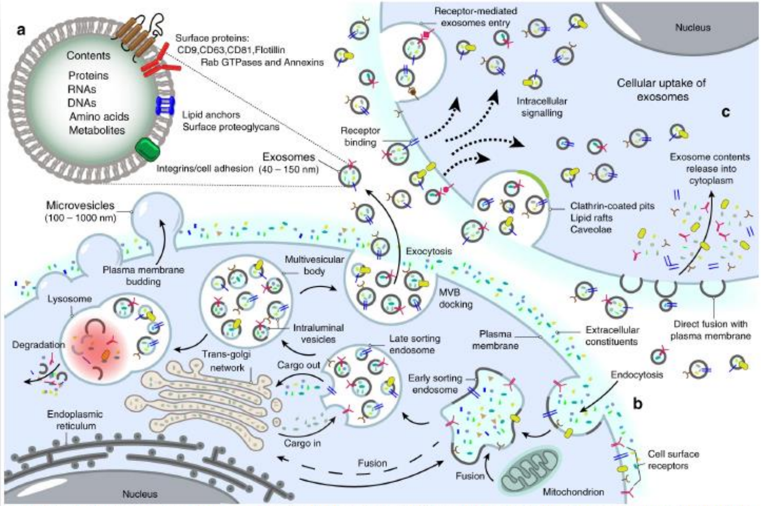


FIGURE 4-5 Intercellular communication. Biochemical cross talk among cells enables communication within and among tissues, organisms, and species—including via exosomes.
SOURCE: From Ni et al. (2020), https://doi.org/10.1038/s41413-020-0100-9. CC BY 4.0.

Impact on Extracellular Molecules and Extracellular Vesicles

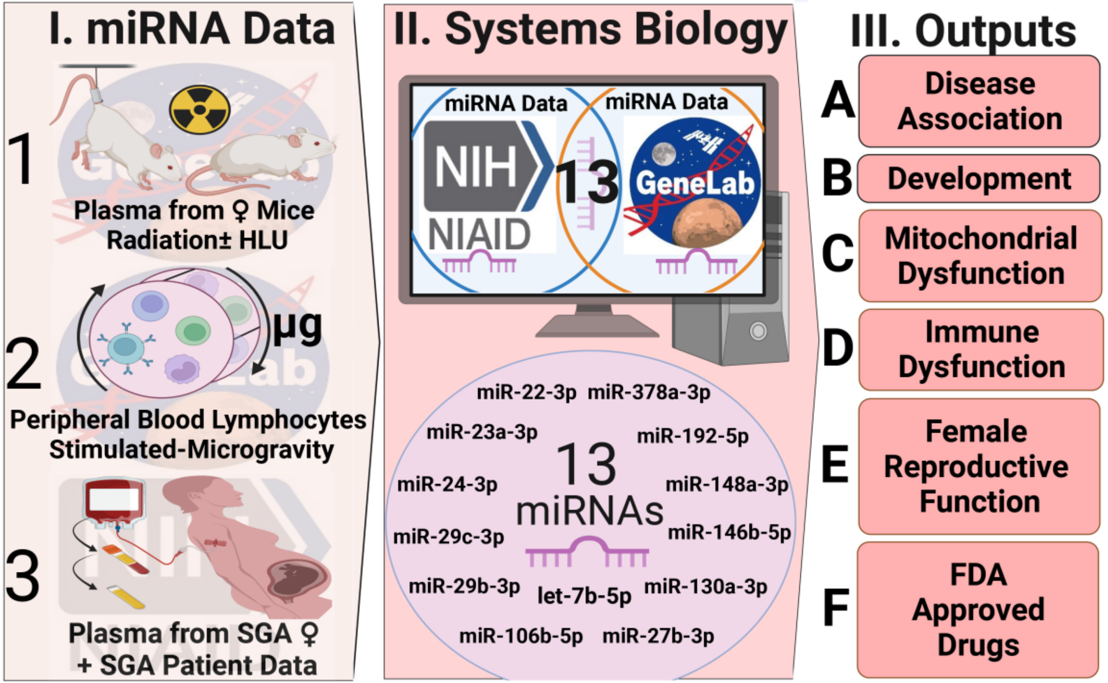
Extracellular vesicles are prime candidates for cross-talk vectors, and their study in organisms in space is critical for an understanding of the biological effects of the space environment. Extracellular molecules are the communicators in intra-organism cross talk and can be either small molecules, protein-based, or nucleic acid–based. Some proteins like insulin or inflammatory response molecules like cytokines have been known for some time, whereas others are still being discovered (e.g., histone variants). Cell-free nucleic acids include several types of DNAs and RNAs, and also have shown responsiveness to spaceflight (e.g., mitochondrial DNA, mtDNA) (Lo et al. 2021). First recognized as biomarkers in cancer patients (Schwarzenbach et al. 2011), these molecules are potentially biomarkers for many more pathologies and homeostasis changes in organisms in the space environment. Indeed, Malkani and colleagues have identified and validated a spaceflight-associated microRNA (miRNA) signature that is shared by rodents and humans in response to simulated short-duration and long-duration spaceflight (Malkani et al. 2020). Additionally, a subset of these miRNAs was found to regulate vascular damage caused by simulated deep-space radiation.

Extracellular vesicles are a heterogeneous group of membrane-limited vesicles loaded with various proteins, lipids, and nucleic acids. Release of extracellular vesicles from its cell of origin occurs

https://nap.nationalacademies.org/catalog/26750/thriving-in-space-ensuring-the-future-of-biological-and-physical-sciences-research-a-decadal-survey-for-2023-2032

Hypothesis:

Does spaceflight increase the chance of potential birth defects?



I. miRNA Data

1 Plasma from ♀ Mice Radiation± HLU

2 Peripheral Blood Lymphocytes Stimulated-Microgravity

3 Plasma from SGA ♀ + SGA Patient Data

II. Systems Biology

13 miRNAs

miR-22-3p miR-378a-3p miR-23a-3p miR-192-5p miR-24-3p miR-148a-3p miR-29c-3p miR-146b-5p miR-29b-3p let-7b-5p miR-130a-3p miR-106b-5p miR-27b-3p

III. Outputs

A Disease Association

B Development

C Mitochondrial Dysfunction

D Immune Dysfunction

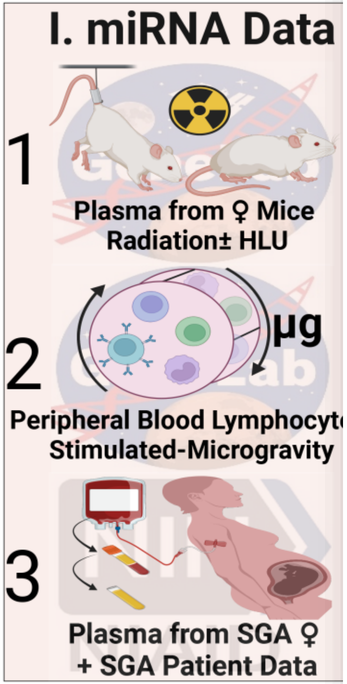
E Female Reproductive Function

F FDA Approved Drugs

Are miRNAs associated with SGA elevated in the plasma of females during spaceflight and can increase the risk of birth defects after returning to Earth???

Hypothesis:

Does spaceflight increase the chance of potential



communications biology

Article | Open access | Published: 05 October 2024

To boldly go where no microRNAs have gone before: spaceflight impact on risk for small-for-gestational-age infants

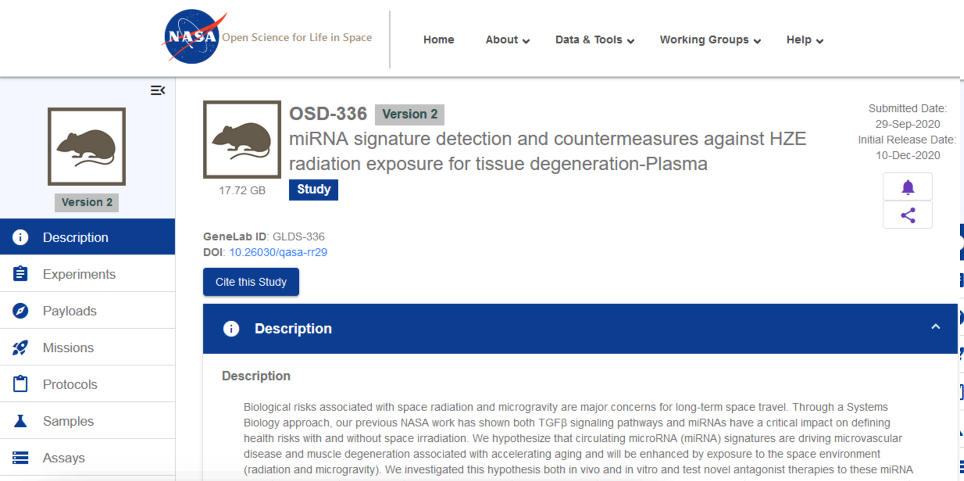
Giada Corti, JangKeun Kim, Francisco J. Enguita, Joseph W. Guarnieri, Lawrence I. Grossman, Sylvain V. Costes, Matias Fuentealba, Ryan T. Scott, Andrea Magrini, Lauren M. Sanders, Kanhaiya Singh, Chandan K. Sen, Cassandra M. Juran, Amber M. Paul, David Furman, Jean Calleja-Agius, Christopher E. Mason, Diego Galeano, Massimo Bottini & Afshin Beheshti ✉

Communications Biology **7**, Article number: 1268 (2024) | Cite this article

ed
he
ing

rth
to

Relating Spaceflight Data to Clinical Data



OSD-336 Version 2

miRNA signature detection and countermeasures against HZE radiation exposure for tissue degeneration-Plasma

17.72 GB **Study**

Submitted Date:
29-Sep-2020
Initial Release Date:
10-Dec-2020

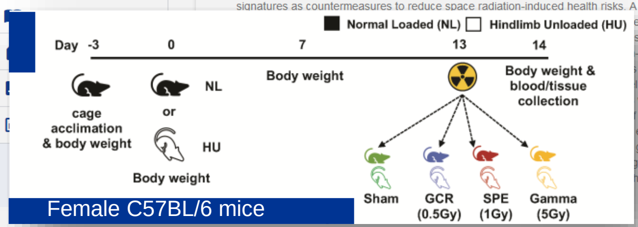
GeneLab ID: GLDS-336
DOI: 10.26030/qasa-rr29

Cite this Study

Description

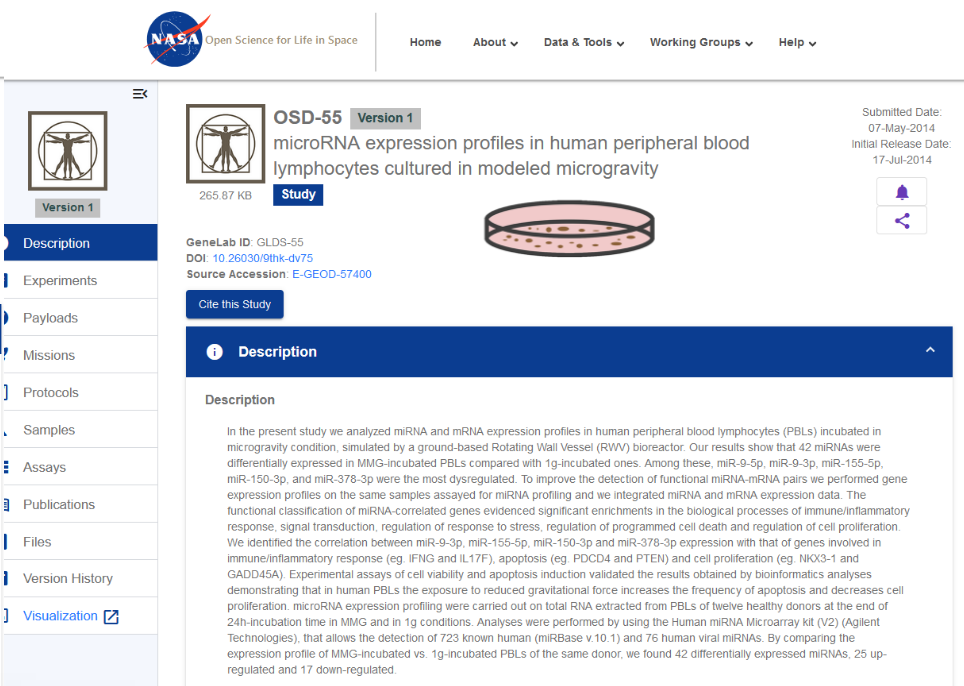
Description

Biological risks associated with space radiation and microgravity are major concerns for long-term space travel. Through a Systems Biology approach, our previous NASA work has shown both TGFβ signaling pathways and miRNAs have a critical impact on defining health risks with and without space irradiation. We hypothesize that circulating microRNA (miRNA) signatures are driving microvascular disease and muscle degeneration associated with accelerating aging and will be enhanced by exposure to the space environment (radiation and microgravity). We investigated this hypothesis both in vivo and in vitro and test novel antagonist therapies to these miRNA signatures as countermeasures to reduce space radiation-induced health risks. A comprehensive Systems Biology approach was used to



Female C57BL/6 mice

energy (E) (HZE) irradiation. To simulate low-dose
s determined by a NASA consensus formula of 7
-dose radiation exposure due to solar particle events
s ranging from 50MeV to 150MeV. C57BL/6 wild-type
l (hindlimb suspension model) and an in vitro 3D
will also be irradiated. To expand on the circulating
f conserved miRNAs which are commonly being
established techniques. MiRNA-sequencing on serum
groups revealed the key circulating miRNA signature
g of how whole body space radiation impacts
hance health risk prognostication and provide possible



OSD-55 Version 1

microRNA expression profiles in human peripheral blood lymphocytes cultured in modeled microgravity

265.87 KB **Study**

Submitted Date:
07-May-2014
Initial Release Date:
17-Jul-2014

GeneLab ID: GLDS-55
DOI: 10.26030/9thk-dv75
Source Accession: E-GEOD-57400

Cite this Study

Description

Description

In the present study we analyzed miRNA and mRNA expression profiles in human peripheral blood lymphocytes (PBLs) incubated in microgravity condition, simulated by a ground-based Rotating Wall Vessel (RWV) bioreactor. Our results show that 42 miRNAs were differentially expressed in MMG-incubated PBLs compared with 1g-incubated ones. Among these, miR-9-5p, miR-9-3p, miR-155-5p, miR-150-3p, and miR-378-3p were the most dysregulated. To improve the detection of functional miRNA-mRNA pairs we performed gene expression profiles on the same samples assayed for miRNA profiling and we integrated miRNA and mRNA expression data. The functional classification of miRNA-correlated genes evidenced significant enrichments in the biological processes of immune/inflammatory response, signal transduction, regulation of response to stress, regulation of programmed cell death and regulation of cell proliferation. We identified the correlation between miR-9-3p, miR-155-5p, miR-150-3p and miR-378-3p expression with that of genes involved in immune/inflammatory response (eg. IFNG and IL17F), apoptosis (eg. PDCD4 and PTEN) and cell proliferation (eg. NKX3-1 and GADD45A). Experimental assays of cell viability and apoptosis induction validated the results obtained by bioinformatics analyses demonstrating that in human PBLs the exposure to reduced gravitational force increases the frequency of apoptosis and decreases cell proliferation. microRNA expression profiling were carried out on total RNA extracted from PBLs of twelve healthy donors at the end of 24h-incubation time in MMG and in 1g conditions. Analyses were performed by using the Human miRNA Microarray kit (V2) (Agilent Technologies), that allows the detection of 723 known human (miRBase v.10.1) and 76 human viral miRNAs. By comparing the expression profile of MMG-incubated vs. 1g-incubated PBLs of the same donor, we found 42 differentially expressed miRNAs, 25 up-regulated and 17 down-regulated.

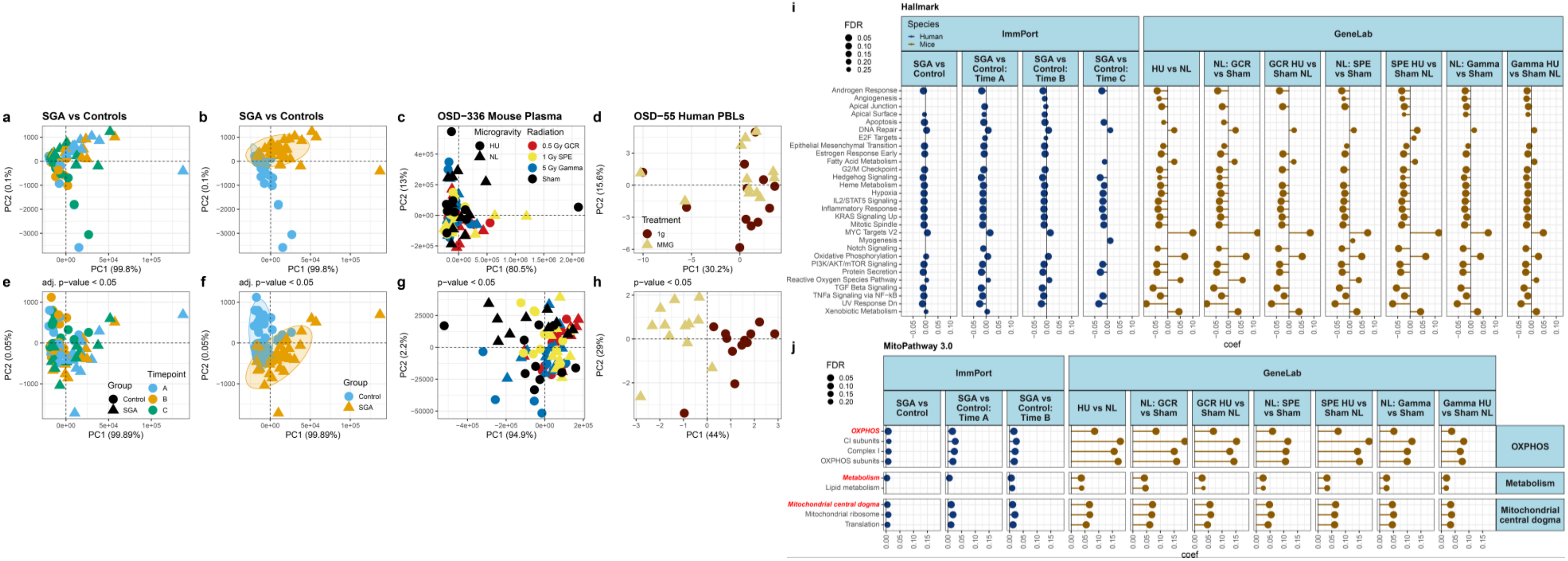
Simplified GCR Sim

Ion species	Energy (MeV/n)	LET (keV/µm)	Dose (mGy)	Dose fraction (mGy)
Proton	1000	0.2	175	0.35
^{28}Si	600	50.4	5	0.01
^{4}He	250	1.6	90	0.18
^{16}O	350	20.9	30	0.06
^{56}Fe	600	173.8	5	0.01
Proton	250	0.4	195	0.39

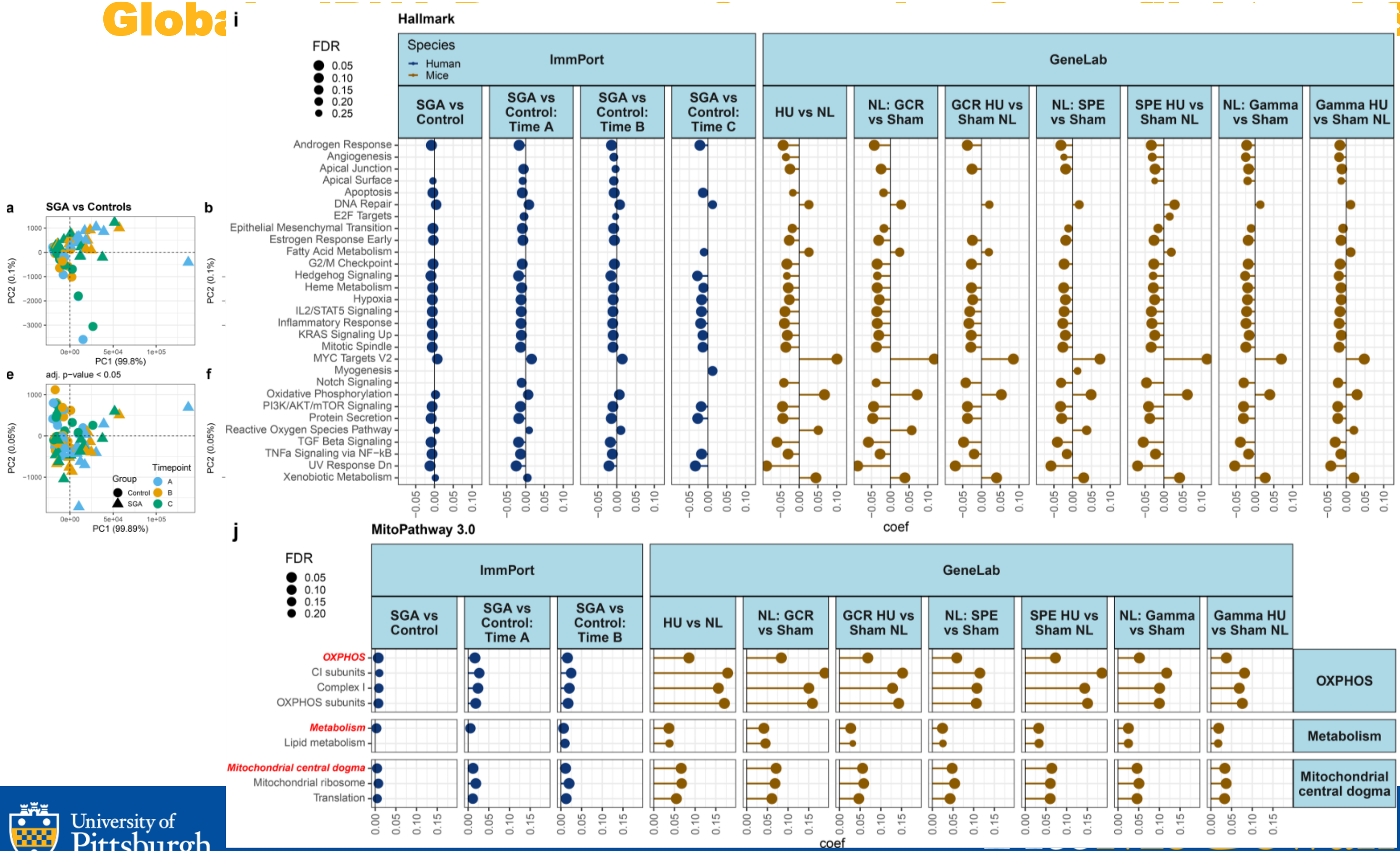
SPE Sim

Ion species	Energy (MeV/n)	Dose (cGy)
Proton	50	91.7
Proton	60	2.9
Proton	70	2.0
Proton	80	1.5
Proton	90	1.1
Proton	100	0.8
Proton	110	0.6
Proton	120	0.4
Proton	130	0.3
Proton	140	0.2
Proton	150	0.1

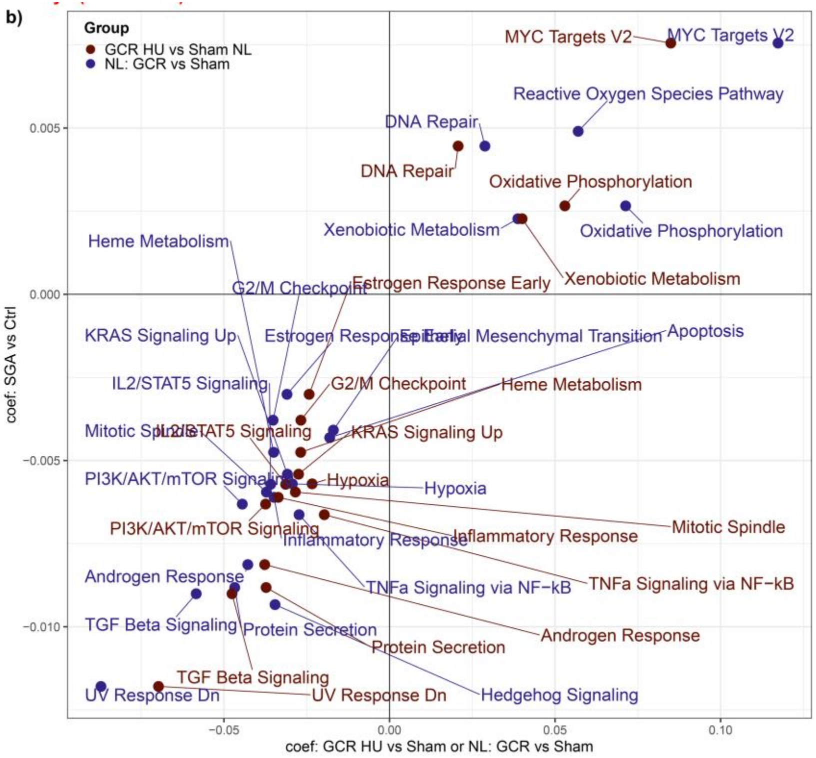
Global miRNA Response Comparing Spaceflight and SGA

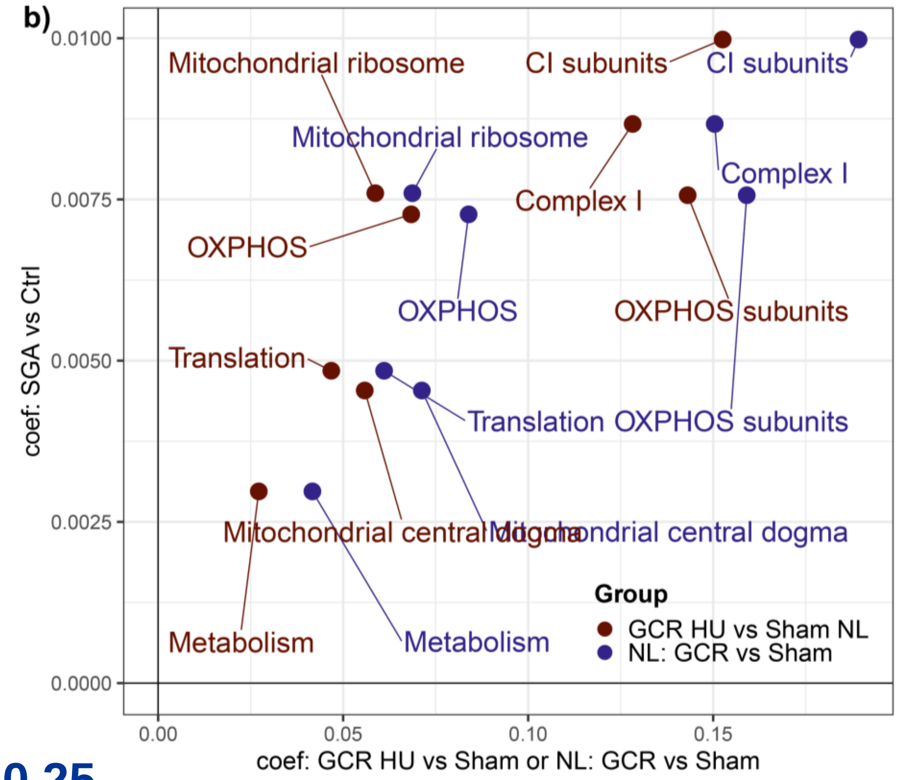


Globa SGA


a
SGA vs Controls
PC2 (0.1%)
PC1 (99.8%)
b
PC2 (0.1%)
e
adj. p−value < 0.05
PC2 (0.05%)
PC1 (99.89%)
Group
Control
SGA
Timepoint
A
B
C
f
PC2 (0.05%)
i
Hallmark
FDR
0.05
0.10
0.15
0.20
0.25
Species
Human
Mice
ImmPort
GeneLab
SGA vs Control
SGA vs Control: Time A
SGA vs Control: Time B
SGA vs Control: Time C
HU vs NL
NL: GCR vs Sham
GCR HU vs Sham NL
NL: SPE vs Sham
SPE HU vs Sham NL
NL: Gamma vs Sham
Gamma HU vs Sham NL
Androgen Response
Angiogenesis
Apical Junction
Apical Surface
Apoptosis
DNA Repair
E2F Targets
Epithelial Mesenchymal Transition
Estrogen Response Early
Fatty Acid Metabolism
G2/M Checkpoint
Hedgehog Signaling
Heme Metabolism
Hypoxia
IL2/STAT5 Signaling
Inflammatory Response
KRAS Signaling Up
Mitotic Spindle
MYC Targets V2
Myogenesis
Notch Signaling
Oxidative Phosphorylation
PI3K/AKT/mTOR Signaling
Protein Secretion
Reactive Oxygen Species Pathway
TGF Beta Signaling
TNFa Signaling via NF−kB
UV Response Dn
Xenobiotic Metabolism
coef
j
MitoPathway 3.0
FDR
0.05
0.10
0.15
0.20
ImmPort
GeneLab
SGA vs Control
SGA vs Control: Time A
SGA vs Control: Time B
HU vs NL
NL: GCR vs Sham
GCR HU vs Sham NL
NL: SPE vs Sham
SPE HU vs Sham NL
NL: Gamma vs Sham
Gamma HU vs Sham NL
OXPHOS
CI subunits
Complex I
OXPHOS subunits
Metabolism
Lipid metabolism
Mitochondrial central dogma
Mitochondrial ribosome
Translation
OXPHOS
Metabolism
Mitochondrial central dogma
coef

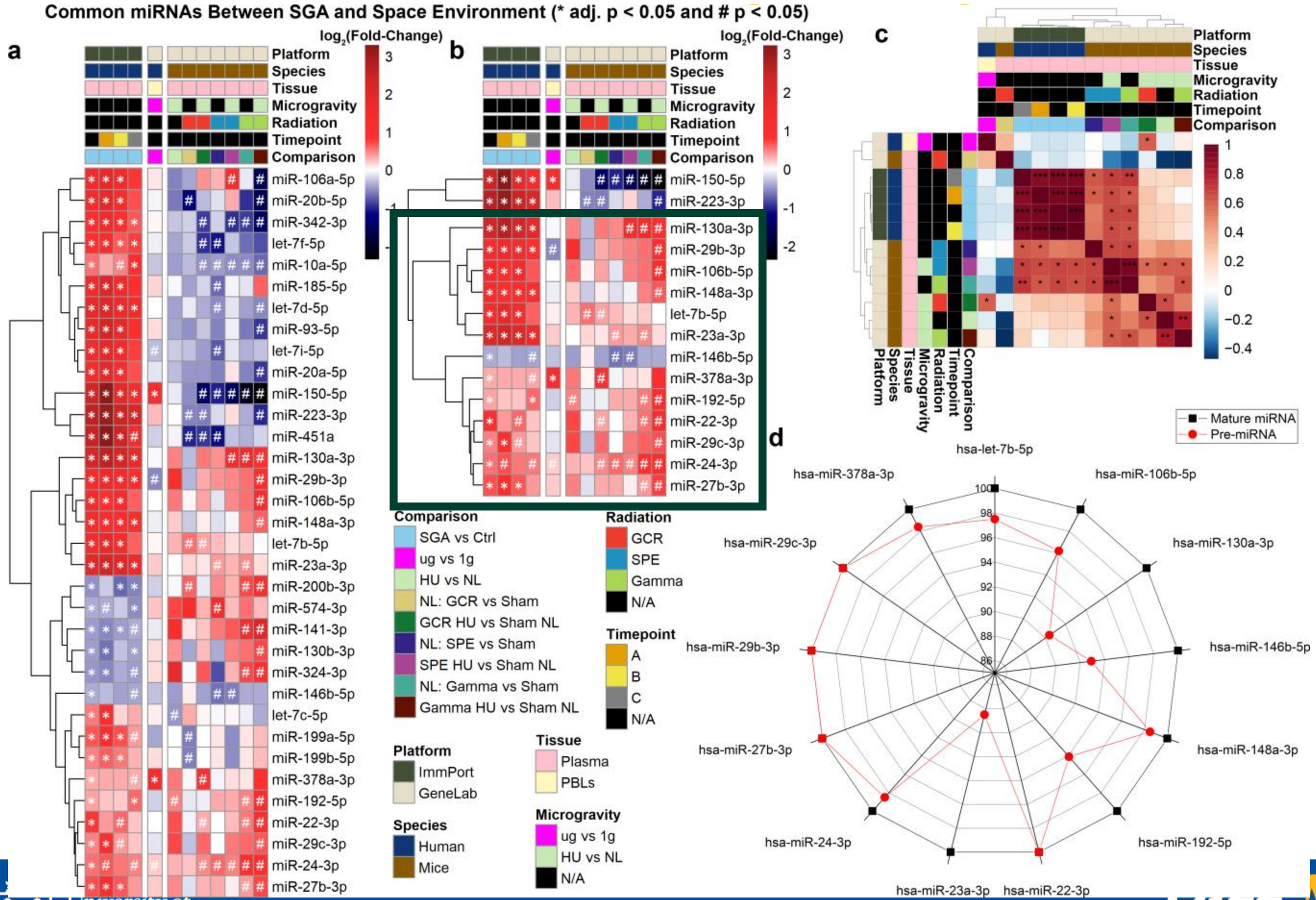
Global miRNA Response Comparing Spaceflight and SGA





FDR < 0.25

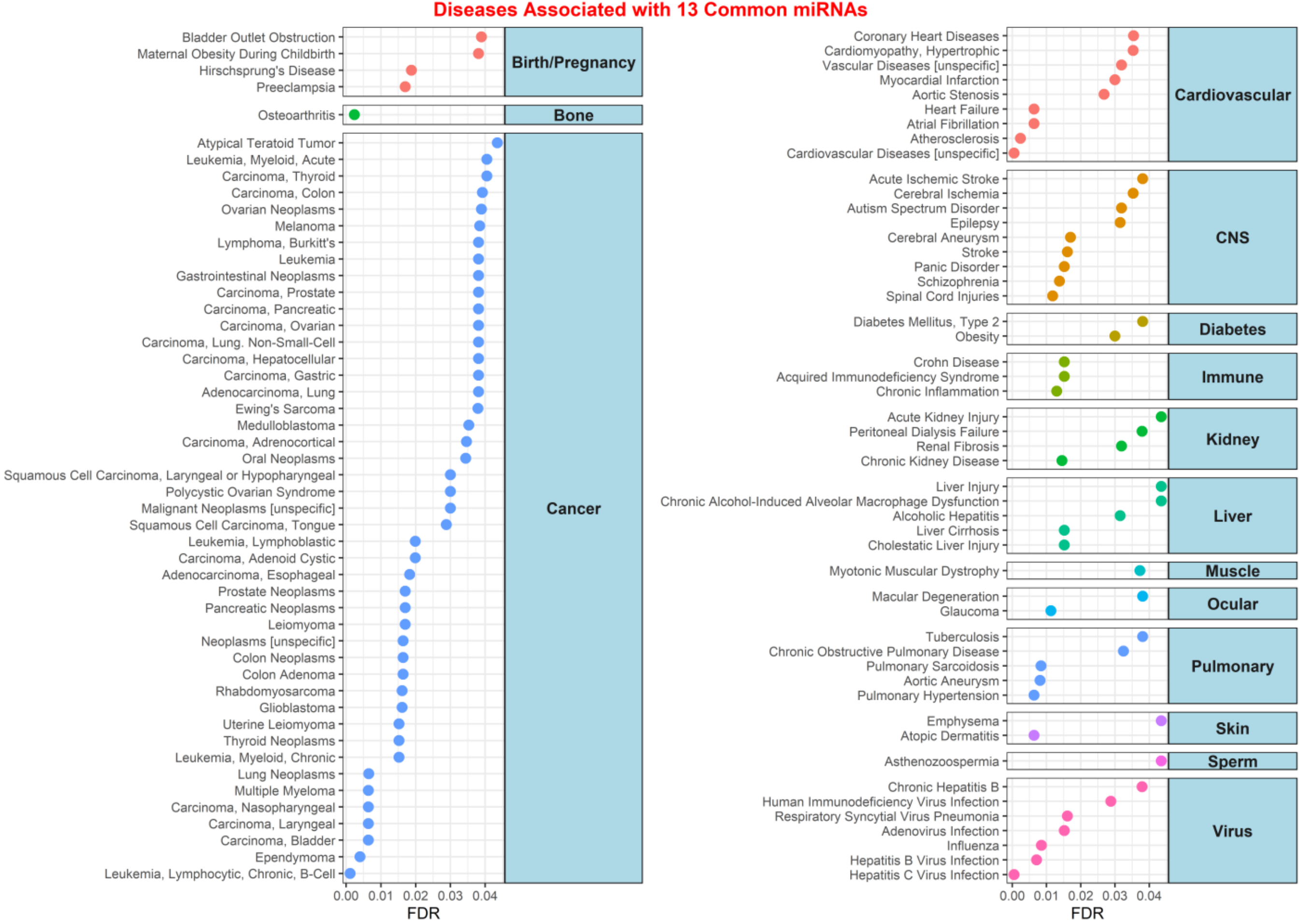
Common Circulating miRNAs Between SGA and



Percentage of homology (same nucleotides in the same positions) between mouse and human miRNAs shows the 13 mature miRNAs are 100% conserved between the two species!!

Francisco "Paco" Enguita, PhD

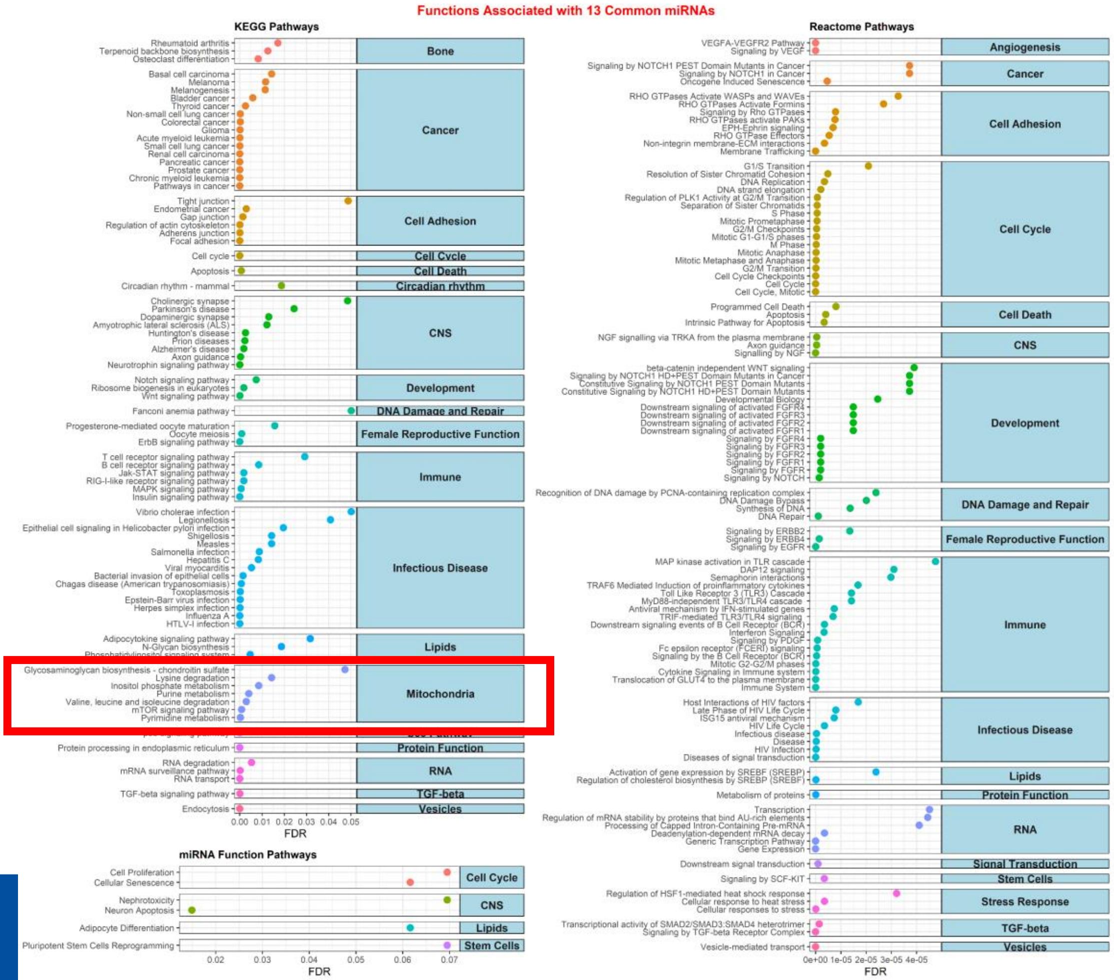
Health Risks Associated with the Common miRNAs


Diseases Associated with 13 Common miRNAs

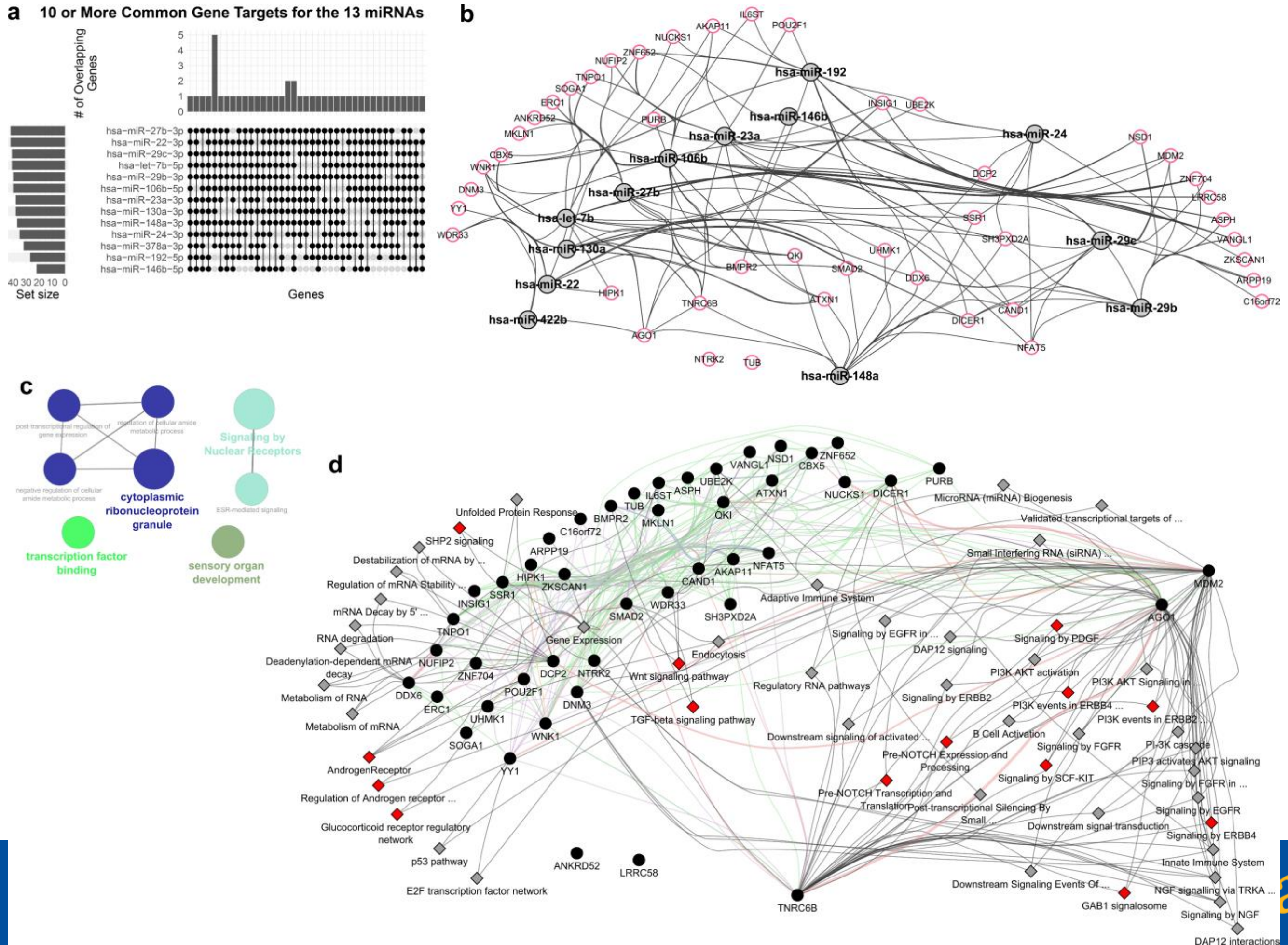
University of Pittsburgh

stitute for
egenerative Medicine

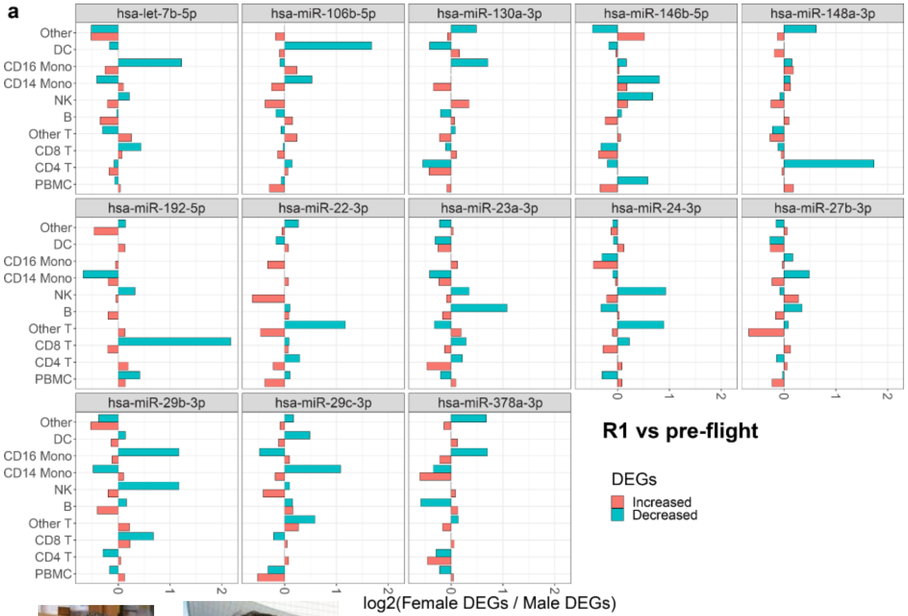
Biological Functions Associated with the Common miRNAs

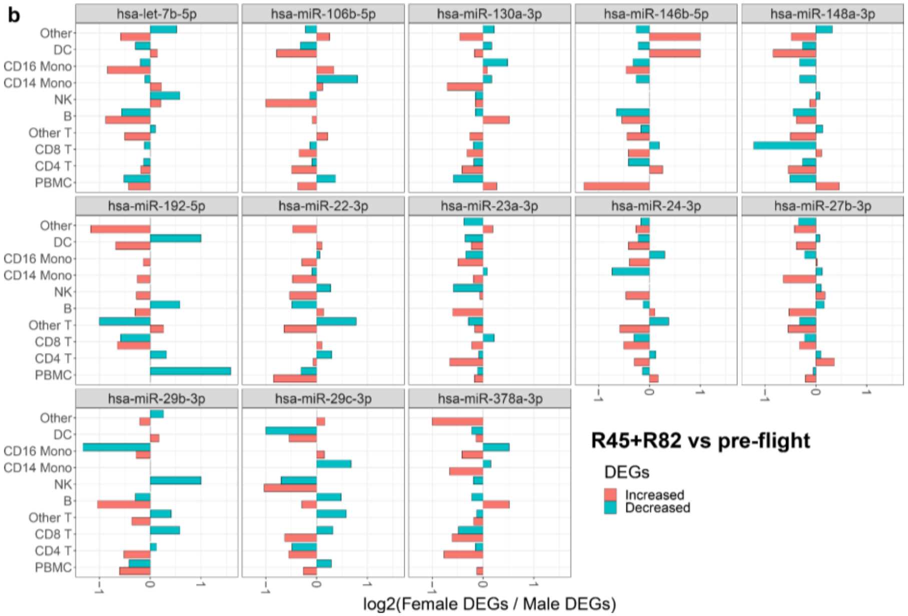


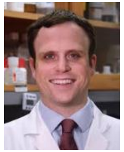
Gene Targets for the Common miRNAs



Gene Targets for the Common miRNAs in Astronauts

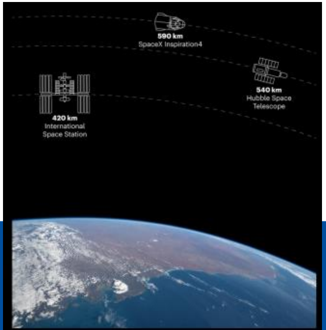






Chris Mason, PhD JangKeun Kim, PhD

Weill Cornell Medicine



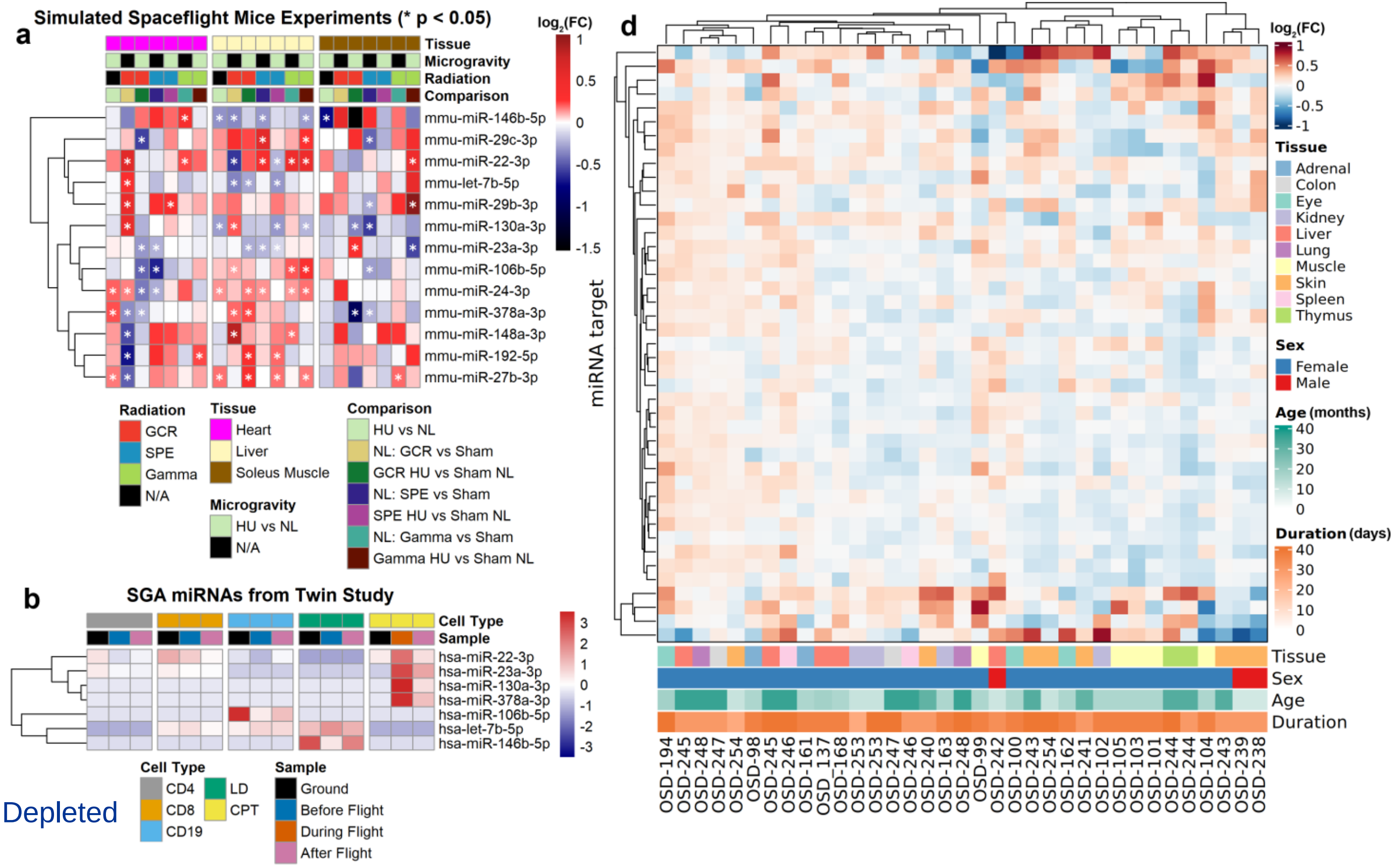
INSPIRATI4N

The First All-Civilian Mission To Orbit

FOUR CREW MEMBERS REPRESENTED THE MISSION PILLARS OF LEADERSHIP, HOPE, GENEROSITY, AND PROSPERITY

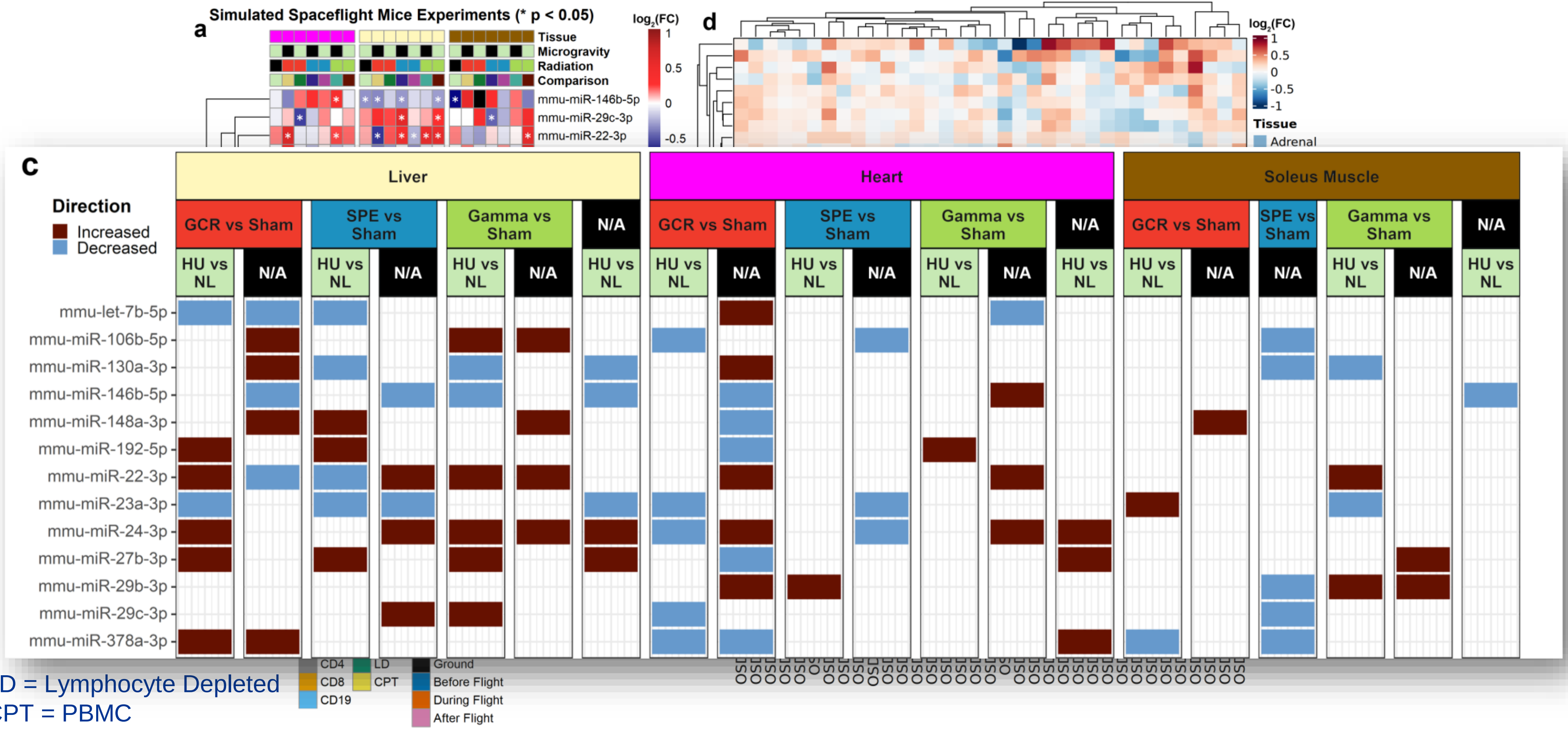
University of Pittsburgh

miRNAs and Gene Targets in other Tissues



LD = Lymphocyte Depleted
CPT = PBMC

miRNAs and Gene Targets in other Tissues

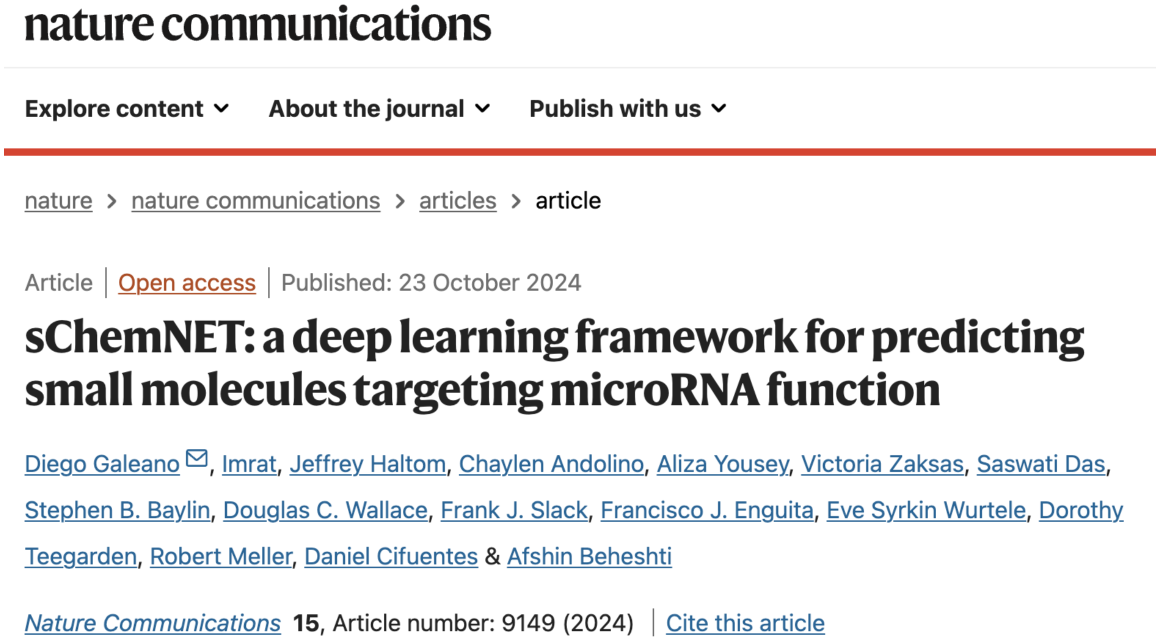


LD = Lymphocyte Depleted

CPT = PBMC

Can we determine potential countermeasures to mitigate the impact of SGA in females during spaceflight and the clinic???

sChemNET: A deep learning framework for predicting miRNA targets of small molecules based on chemical structure



nature communications

Explore content ⌄ About the journal ⌄ Publish with us ⌄

nature › nature communications › articles › article

Article | Open access | Published: 23 October 2024

sChemNET: a deep learning framework for predicting small molecules targeting microRNA function

Diego Galeano ✉, Imrat, Jeffrey Haltom, Chaylen Andolino, Aliza Yousey, Victoria Zaksas, Saswati Das, Stephen B. Baylin, Douglas C. Wallace, Frank J. Slack, Francisco J. Enguita, Eve Syrkin Wurtele, Dorothy Teegarden, Robert Meller, Daniel Cifuentes & Afshin Beheshti

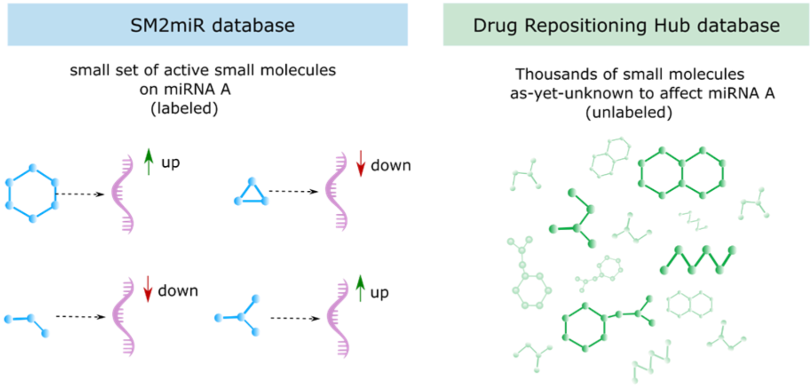
Nature Communications **15**, Article number: 9149 (2024) | Cite this article

https://www.nature.com/articles/s41467-024-49813-w

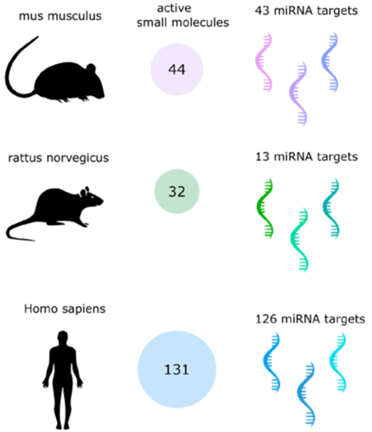
Diego Galeano, PhD

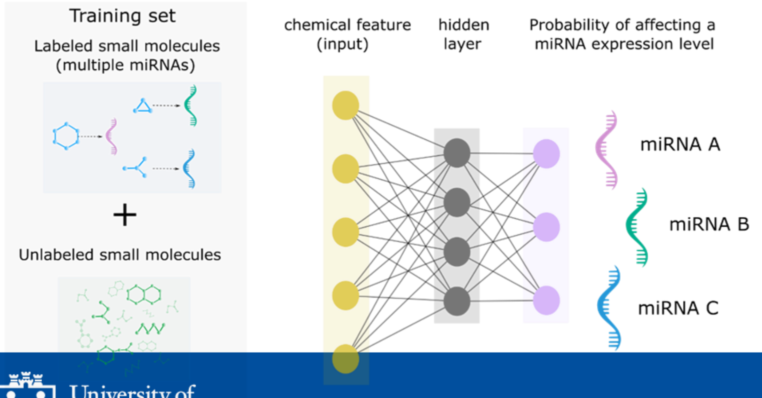
UNIVERSIDAD NACIONAL DE ASUNCION · REPUBLICA DEL PARAGUAY

sChemNET: A deep learning framework for predicting miRNA targets of small molecules based on chemical structure



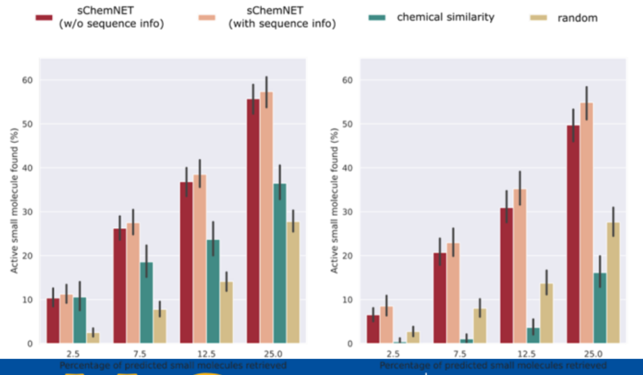
- Given a small molecule's chemical structure, sChemNET predicts whether it will affect miRNA targets
- We tested sChemNET for chemical data from homo sapiens and other model organisms
- sChemNET can be used in any chemical library for an *in-silico* screening against miRNA targets





sChemNET minimizes the following loss function

$$\mathcal{L} = \frac{1}{2}\sum_{(i,v)\ is\ labelled} s_{uv}(\hat{y}_{iv} - y_{iv})^2 + \frac{\alpha}{2}\sum_{(i,v)\ is\ unlabelled} \hat{y}_{iv}{}^2$$



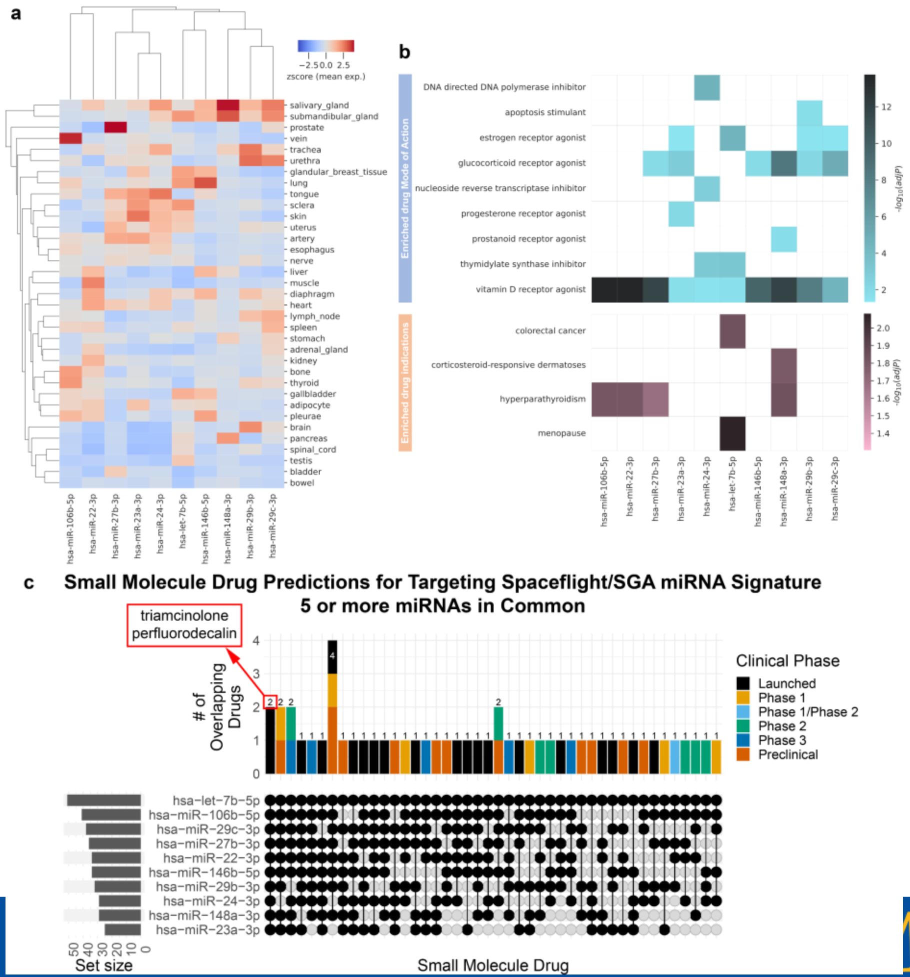
Diego Galeano, PhD

Universidad Nacional de Asunción · República del Paraguay

University of Pittsburgh

Pitt McGowan Institute for Regenerative Medicine

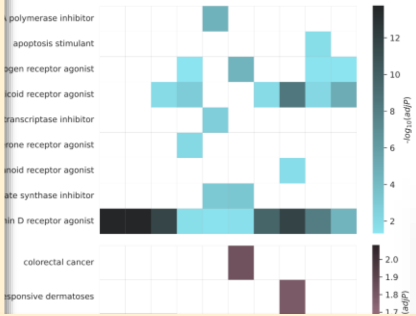
sChemNET's predictions for our miRNA signature

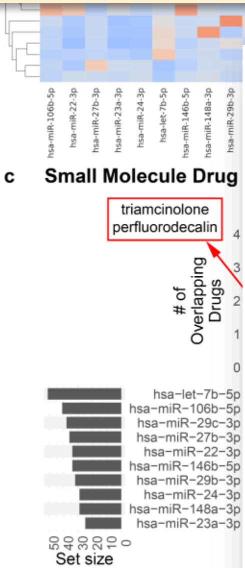


Diego Galeano, PhD

sChemNET's predictions for our miRNA signature

Triamcinolone is a glucocorticoid used to treat a number of different medical conditions, such as eczema, alopecia areata, lichen sclerosus, psoriasis, arthritis, allergies, ulcerative colitis, lupus, sympathetic ophthalmia, temporal arteritis, uveitis, ocular inflammation, keloids, urushiol-induced contact dermatitis, aphthous ulcers (usually as triamcinolone acetonide), central retinal vein occlusion, visualization during vitrectomy and the prevention of asthma attacks.





Perfluorodecalin was an ing
roduct develo
the 1980s. It is
g.Perfluorodec
a oxygen to a specific location, to
und healing. Organs and tissues can be

Experimental and Numerical Modeling of Aerosol Delivery for Preterm Infants

by Iñigo Aramendia 1,*, Unai Fernandez-Gamiz 1, Alberto Lopez-Arraiza 2, Carmen Rey-Santano 3, Victoria Mielgo 3, Francisco Jose Basterretxea 4, Javier Sancho 1 and Miguel Angel Gomez-Solaetxe 2

1 Nuclear Engineering and Fluid Mechanics Department, University of the Basque Country UPV/EHU, 01006 Vitoria-Gasteiz, Araba, Spain
2 Department of Nautical Science and Marine Systems, University of the Basque Country UPV/EHU, 48013 Portugalete, Bizkaia, Spain
3 Animal Research Unit, BioCruces Health Research Institute, 48903 Barakaldo, Bizkaia, Spain
4 Department of Physical Chemistry, University of the Basque Country UPV/EHU, 48940 Leioa, Bizkaia, Spain
* Author to whom correspondence should be addressed.

Int. J. Environ. Res. Public Health **2018**, *15*(3), 423; https://doi.org/10.3390/ijerph15030423

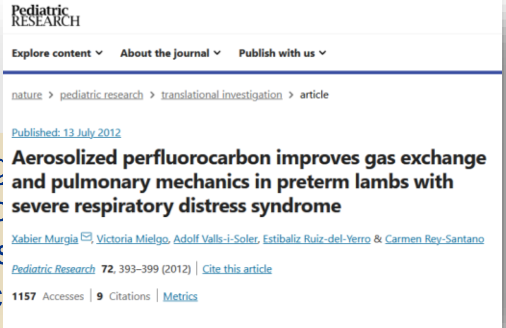
Received: 20 November 2017 / Revised: 12 February 2018 / Accepted: 23 February 2018 / Published: 28 February 2018

(This article belongs to the Section Environmental Health)

Abstract

Respiratory distress syndrome (RDS) represents one of the major causes of mortality among preterm infants, and the best approach to treat it is an open research issue. The use of perfluorocarbons (PFC) along with non-invasive respiratory support techniques has proven the usefulness of PFC as a complementary substance to achieve a more homogeneous surfactant distribution. The aim of this work was to study the inhaled particles generated by means of an intracorporeal inhalation catheter, evaluating the size and mass distribution of different PFC aerosols. In this article, we discuss different experiments with the PFC perfluorodecalin (PFD) and FC75 with a driving pressure of 4–5 bar, evaluating properties such as the aerodynamic diameter (D…) since its value is directly linked to particle deposition in the lung. Furthermore, we develop a numerica… th computational fluid dynamics (CFD) techniques. The computational results showed an accurate … of the airflow axial velocity at different downstream positions when compared with the data gathered from the real experiments. The numerical validation of the cumulative mass distribution for PFD particles also confirmed a closer match with the experimental data measured at the optimal distance of 60 mm from the catheter tip. In the case of FC75, the cumulative mass fraction for particles above 10 μm was considerable higher with a driving pressure of 5 bar. These numerical models could be a helpful tool to assist parametric studies of new non-invasive devices for the treatment of RDS in preterm infants.

Keywords: aerosol; CFD; inhalation catheter; perfluorocarbons; respiratory distress syndrome



Published: 13 July 2012

Aerosolized perfluorocarbon improves gas exchange and pulmonary mechanics in preterm lambs with severe respiratory distress syndrome

Xabier Murgia, Victoria Mielgo, Adolf Valls-i-Soler, Estibaliz Ruiz-del-Yerro & Carmen Rey-Santano

Pediatric Research **72**, 393–399 (2012) | Cite this article

1157 Accesses | **9** Citations | Metrics

RESEARCH ARTICLE | VOLUME 38, ISSUE 1, P17-20, JANUARY 2003

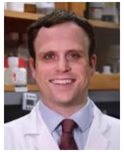
Early perfluorodecalin lung distension in infants with congenital diaphragmatic hernia

G.M. Walker • K.F. Kasem • S.J. O'Toole • A. Watt • C.H. Skeoch • C.F. Davis

DOI: https://doi.org/10.1053/jpsu.2003.50002

Diego Galeano, PhD

Acknowledgments


Chris Mason, PhD


JangKeun Kim, PhD

Weill Cornell Medicine


Francisco Enguita, PhD

U LISBOA UNIVERSIDADE DE LISBOA


Joseph Guarnieri, PhD

Children's Hospital of Philadelphia


Lawrence Grossman, PhD

WAYNE STATE UNIVERSITY


Sylvain Costes, PhD

NASA SILICON VALLEY AMES RESEARCH CENTER


Lauren Sanders, PhD

Blue Marble Space Institute of Science

NASA SILICON VALLEY AMES RESEARCH CENTER


Ryan Scott

KBR We Deliver

NASA SILICON VALLEY AMES RESEARCH CENTER


Diego Galeano, PhD

UNIVERSIDAD NACIONAL DE ASUNCION REPUBLICA DEL PARAGUAY


Massimo Bottini, PhD

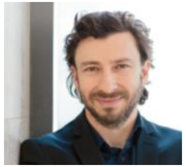

Giada Corti


Andrea Magrini, PhD

TOR VERGATA UNIVERSITÀ DEGLI STUDI DI ROMA


Jean Calleja Agius, MD

L-Università ta' Malta


David Furman, PhD


Matias Fuentealba, PhD

Buck
Live better longer.


communications biology

Explore content ⌄ About the journal ⌄ Publish with us ⌄

nature › communications biology › articles › article

Article | Open access | Published: 05 October 2024

To boldly go where no microRNAs have gone before: spaceflight impact on risk for small-for-gestational-age infants

Giada Corti, JangKeun Kim, Francisco J. Enguita, Joseph W. Guarnieri, Lawrence I. Grossman, Sylvain V. Costes, Matias Fuentealba, Ryan T. Scott, Andrea Magrini, Lauren M. Sanders, Kanhaiya Singh, Chandan K. Sen, Cassandra M. Juran, Amber M. Paul, David Furman, Jean Calleja-Agius, Christopher E. Mason, Diego Galeano, Massimo Bottini & Afshin Beheshti ✉

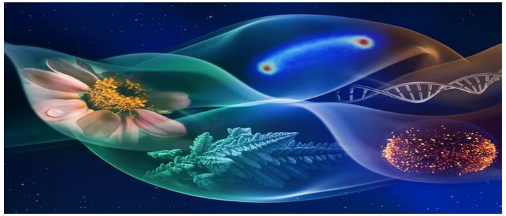
Communications Biology **7**, Article number: 1268 (2024) | Cite this article

This work is supported by:

Part of the work was performed under the Funding from NASA's Biological and Physical Sciences Division to NASA Ames under the Task: ID016GLS Contract Number: NNA14AB82C.

Current Space Funding

NASA Selects 11 Space Biology Research Projects to Inform Biological Research During Future Lunar Exploration Missions



https://science.nasa.gov/science-research/biological-physical-sciences/nasa-selects-11-space-biology-research-projects/

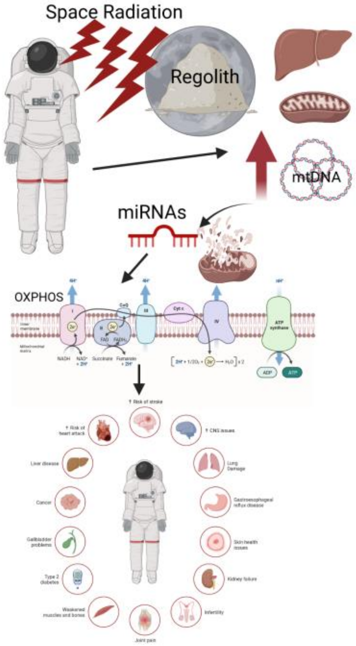
Animal Research Investigations

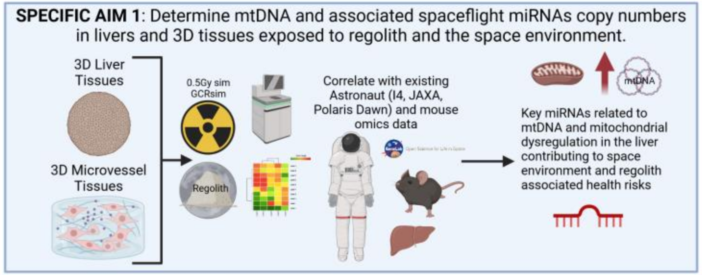
Cheryl Nickerson, Arizona State University

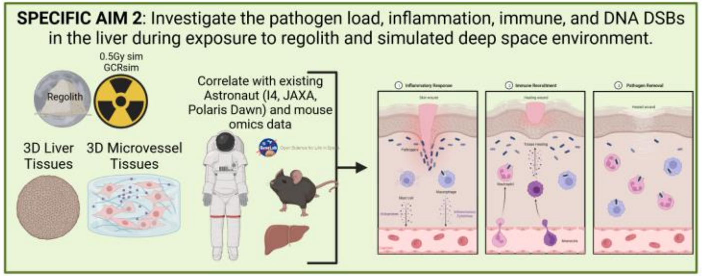
Effects of Lunar Dust Simulant on Human 3-D Biomimetic Intestinal Models, Enteric Microorganisms, and Infectious Disease Risks

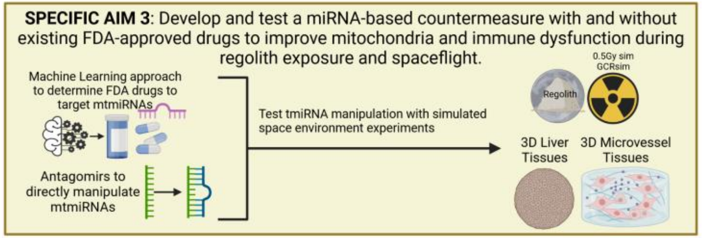
Afshin Beheshti, Ph.D. NASA Ames Research Center*Spaceflight and Regolith Induced Mitochondrial Stress Mitigated by miRNA-based Countermeasures*

Hypothesis: We hypothesize during exposure to regolith and spaceflight, there is an increase in oxidative phosphorylation (OXPHOS) in the liver is due to increases in mitochondrial DNA (mtDNA) driven by microRNAs (miRNAs) creating a systemic impact on the body.




SPECIFIC AIM 1: Determine mtDNA and associated spaceflight miRNAs copy numbers in livers and 3D tissues exposed to regolith and the space environment.


SPECIFIC AIM 2: Investigate the pathogen load, inflammation, immune, and DNA DSBs in the liver during exposure to regolith and simulated deep space environment.


SPECIFIC AIM 3: Develop and test a miRNA-based countermeasure with and without existing FDA-approved drugs to improve mitochondria and immune dysfunction during regolith exposure and spaceflight.