Orbiting Innovation: How Space Research is Transforming Global Health

IPA Webinar

8th May 2025

Host:
- Dr. Shridhar Narayanan

Panelists:
- Adeel NASIR, Ph.D.
- Antariksh Parichha
- Jibin Jeffrey Dhanaraj
- Suresh Poosala

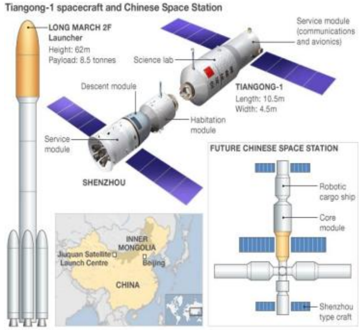
How spacefaring is helping us to improve human health on Earth

Adeel NASIR, Ph.D.
Scientific Advisor, SpaceBorn United

You may call me a Rocket Biologist

Space biology research

Gravity and Light sensing mechanism *in unicellular organisms Euglena gracilis*



CNSA

DLR Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Biological life support system for space travel

NASA

Details of identified floating object

Name: Adeel NASIR (Ph.D.)
Profession: Biologist
Passion: Space biology

Drug development

Parkinsonism & Related Disorders

Articles Publish Topics About Contact

ABSTRACT · Volume 122, 106823, May 2024

Saving dopaminergic neurons from endoplasmic reticulum (ER) stress - A breakthrough approach to fight Parkinson's disease

L. Gentile[1] · A. Nasir[1] · M. Sinane[1] · P. Conan[1] · A.-K. Ückert[2] · M. Leist[2] · G. Friocourt[1] · C. Trollet[3] · F. Bihel[4] · C. Voisset[1] Show less

Affiliations & Notes Article Info

Inserm
La science pour la santé
From science to health

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Ruthenium(II) Polypyridyl Complexes for Antimicrobial Photodynamic Therapy: Prospects for Application in Cystic Fibrosis Lung Airways

by Raphaëlle Youf[1], Adeel Nasir[1], Mareike Müller[2], Franck Thétiot[3], Tanguy Haute[1], Rosy Ghanem[1], Ulrich Jonas[4], Holger Schönherr[2], Gilles Lemercier[5], Tristan Montier[1,6] and Tony Le Gall[1,*]

You may call me a Rocket Biologist

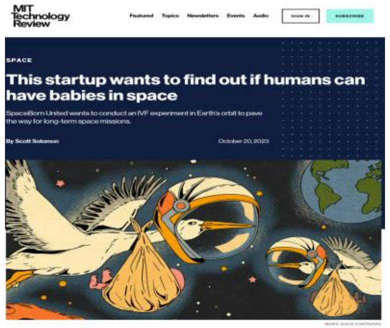
Intercontinental engagements

Netherlands

SPACEBORN UNITED

Life science R&D Project consultant
(Remote)

Project
Development of mini lab for Assisted reproductive technology in space (ARTIS).



Australia

RESEARCHSAT
Satellites for Life-Sciences

Life science R&D Advisor
(Remote)

Services
- ➔ Experimental design
- ➔ Payload development
- ➔ Devise strategies for biofabrication in microgravity

MISSION
We believe each microgravity experiment makes the world a bit healthier world.

FRANCE

Rocket Biologist
Launching soon

Podcast
(Based in France)

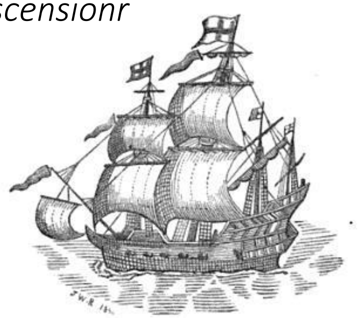
https://www.youtube.com/@RocketBiologist
- ➔ Talking to experts
- ➔ On a mission to promote space biology research across the world and especially for non-space faring countries.

Human exploration on Earth and in space: Its impact on medicine

Age of colonization on Earth for resources

1600: British East India company

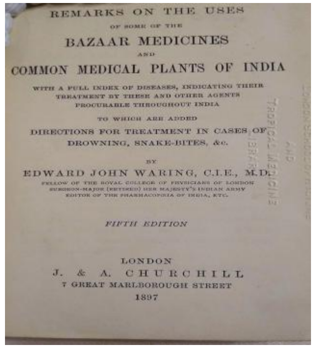
Red dragon
- ➔ *Hector*
- ➔ *Ascensionr*



1602: Red dragon at Achen Indonesia

1608 August: Hector at Surat India

Edward John Waring (14 December 1819 – 22 January 1891) was a Fellow of the Royal College of Physicians of London



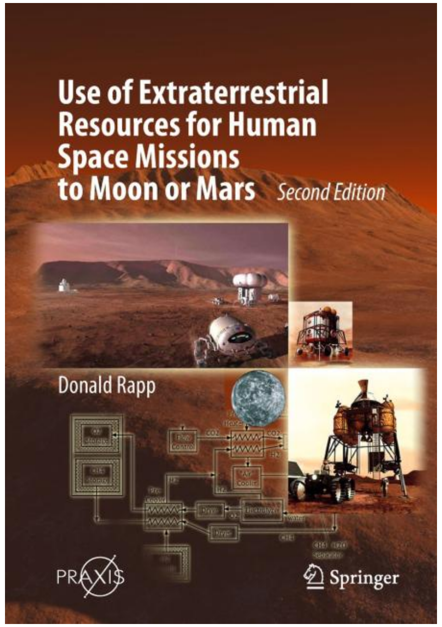
REMARKS ON THE USES
OF SOME OF THE
BAZAAR MEDICINES
AND
COMMON MEDICAL PLANTS OF INDIA
WITH A FULL INDEX OF DISEASES, INDICATING THEIR TREATMENT BY THESE AND OTHER AGENTS PROCURABLE THROUGHOUT INDIA
TO WHICH ARE ADDED
DIRECTIONS FOR TREATMENT IN CASES OF DROWNING, SNAKE-BITES, &c.
BY
EDWARD JOHN WARING, C.I.E., M.D.
FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS OF LONDON
SURGEON-MAJOR (RETIRED) HER MAJESTY'S INDIAN ARMY
EDITOR OF THE PHARMACOPŒIA OF INDIA, ETC.
FIFTH EDITION
LONDON
J. & A. CHURCHILL
7 GREAT MARLBOROUGH STREET
1897

Source: https://www.youtube.com/@DekhoSunoJano

Human exploration on Earth and in space: Its impact on medicine

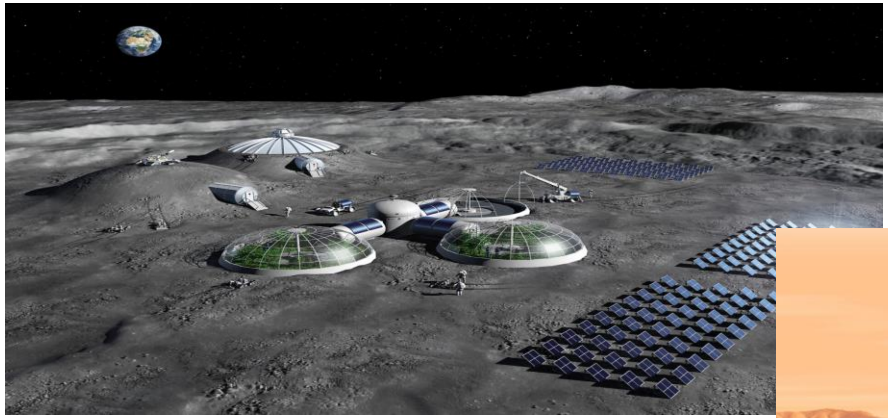
Age of colonization of other planets for resources

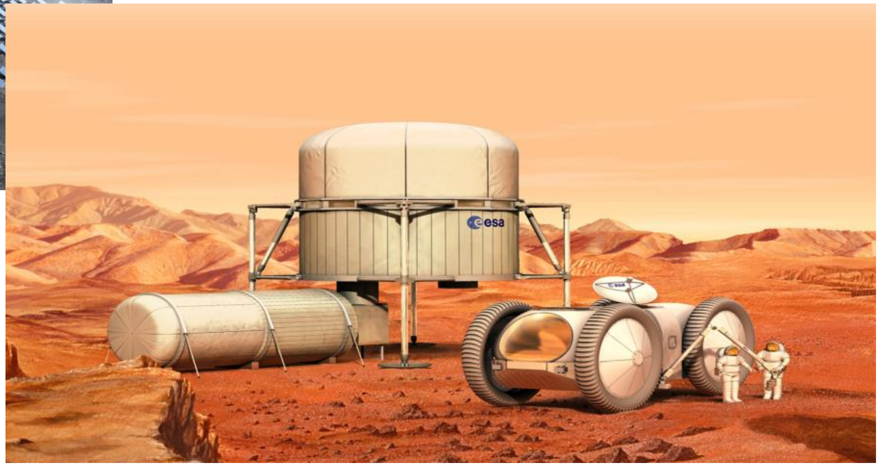
Destination Mars



Rapp 2018

Lunar Base

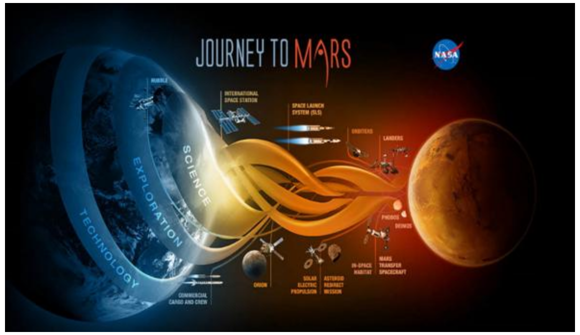




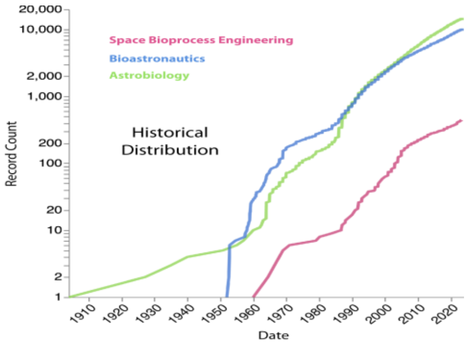
Credit: ESA

Human exploration on Earth and in space: Its impact on medicine

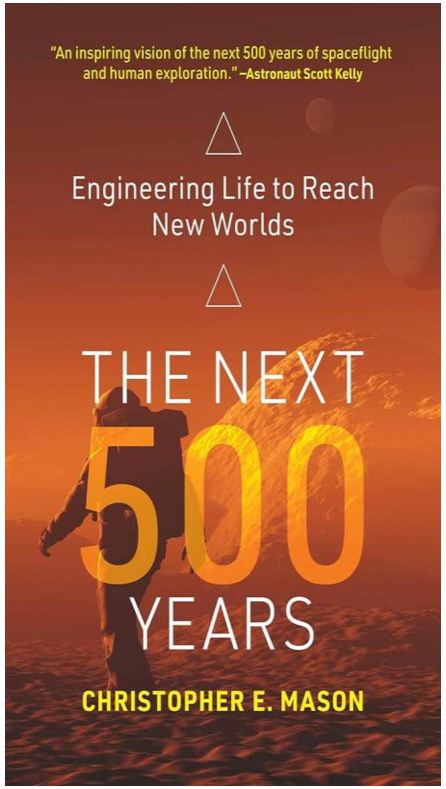
Biology as a tool for sustainable existence off Earth



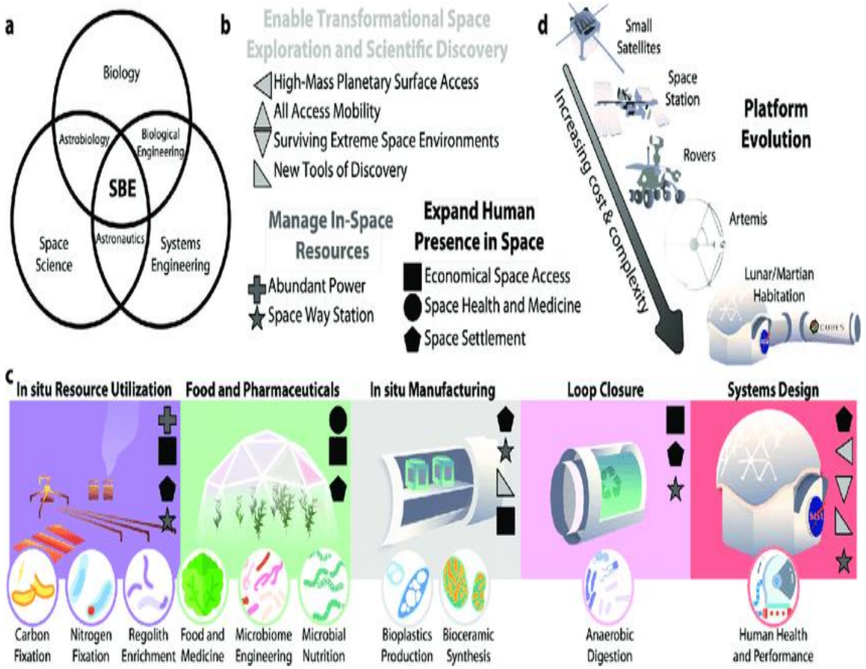
Liu et al., 2021



Berliner et al., 2024



Space bioprocess engineering (SBE) challenges



Berliner et al., 2022

Human exploration on Earth and in space: Its impact on medicine

Learnings from space

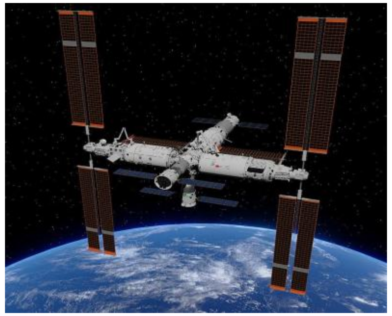
Space stations

Skylab (1973 to 1974)

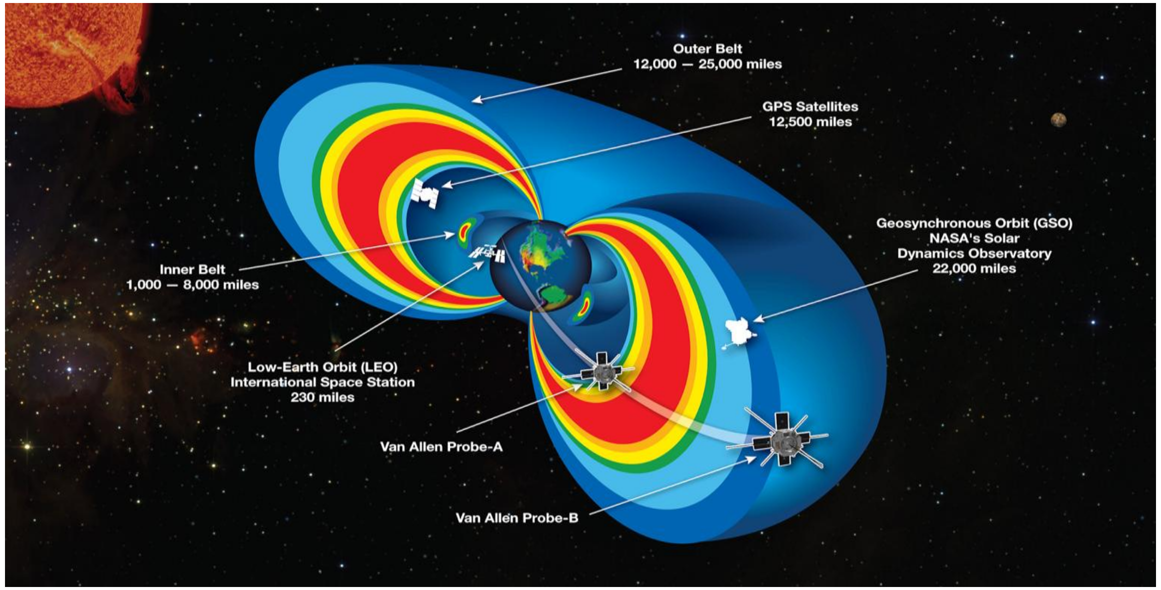
Mir (1986 to 2001)

International space station (1998-present)

Tiangong (2021-present)



Locations of space stations

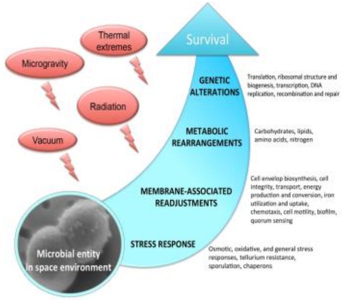


Barthel and Sarigul-Klijn 2019

Human exploration on Earth and in space: Its impact on medicine

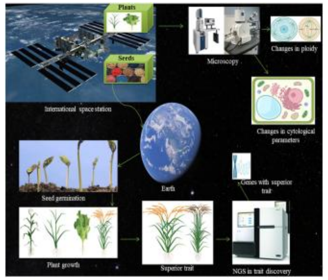
How Earth based life respond to space conditions

Microbes



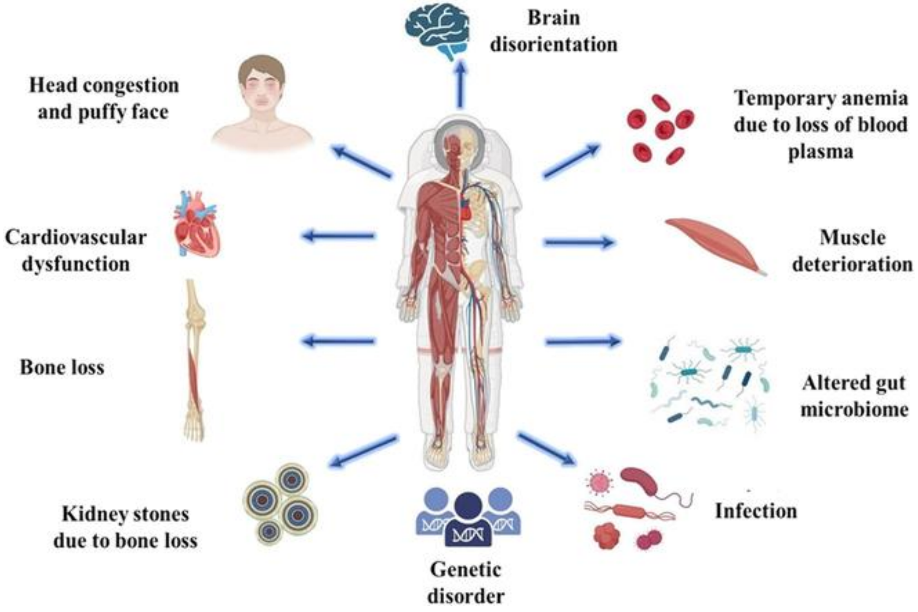
Milojevic and Weckworth., 2020

Plants



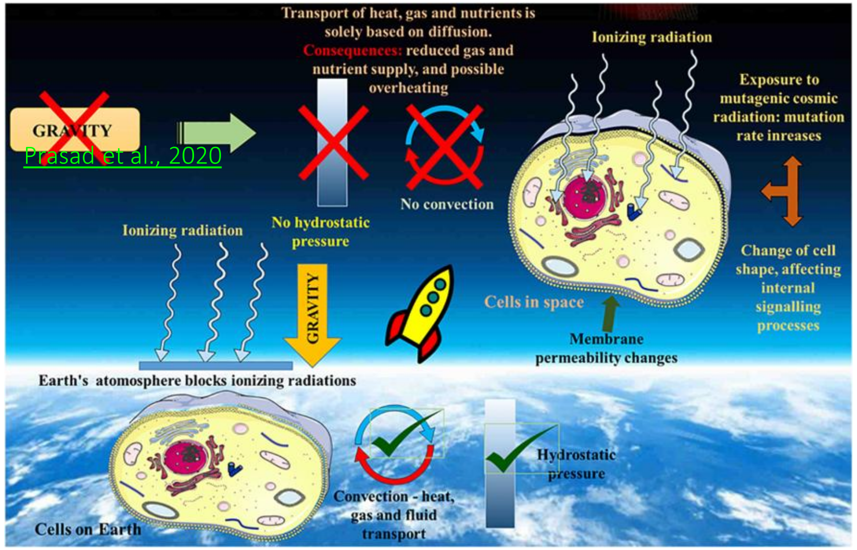
Mohanta et al., 2021

Human



Wani et al., 2024

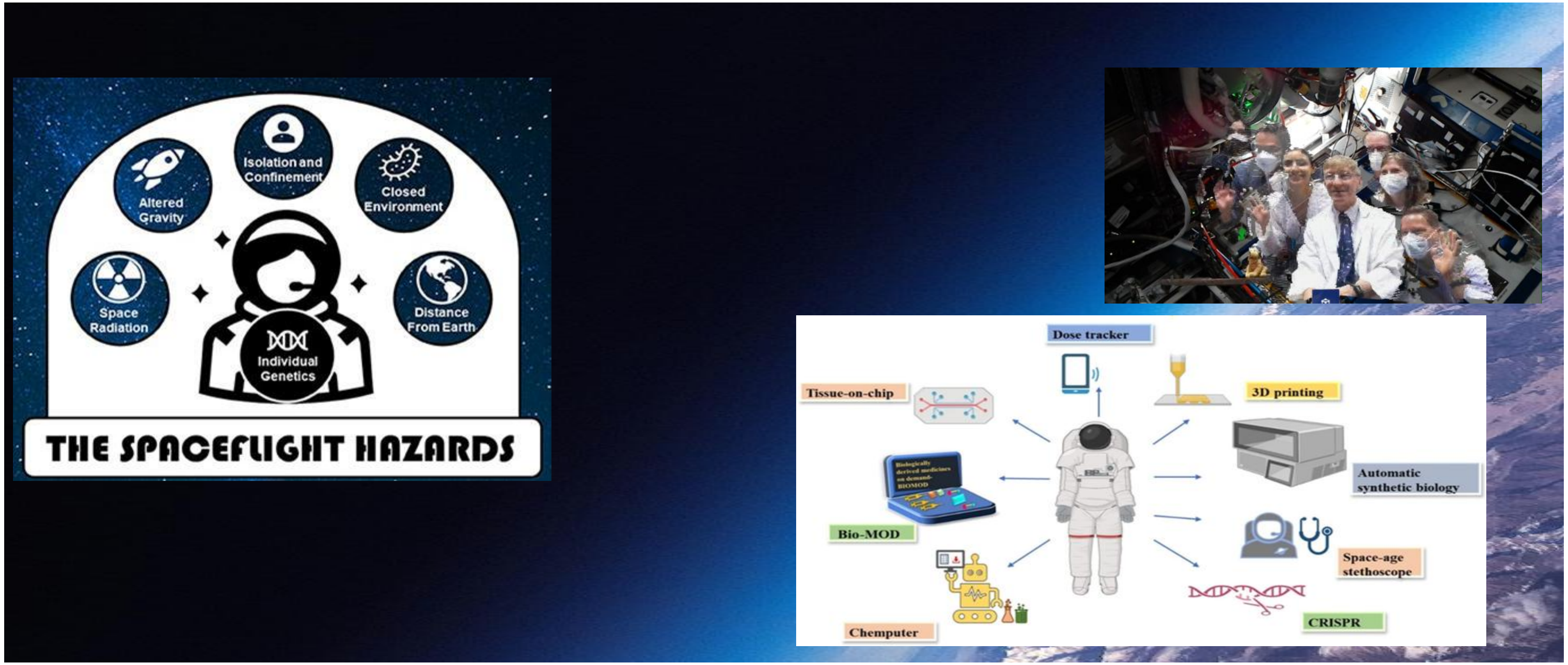
Consequences at the cellular level



Prasad et al., 2020

Human exploration on Earth and in space: Its impact on medicine

Strategies to Counter the Effects of Space on Human Health



Source NASA: Holoportation of Doctors on ISS. B Miller 2024 Wani et al., 2024

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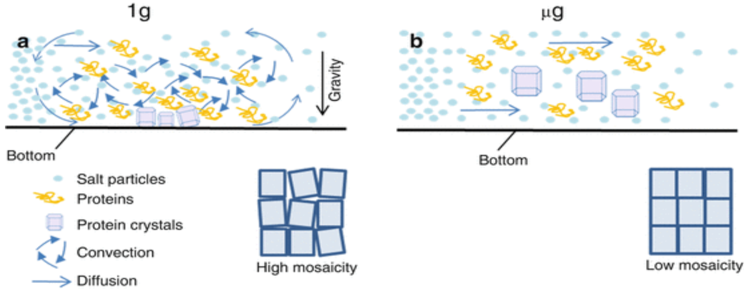
Human exploration on Earth and in space: Its impact on medicine

Roadmap for the use of space environment for the improvement of human health

Drug development



Ruyters & Betzel ., 2017

Curiosity

Creativity

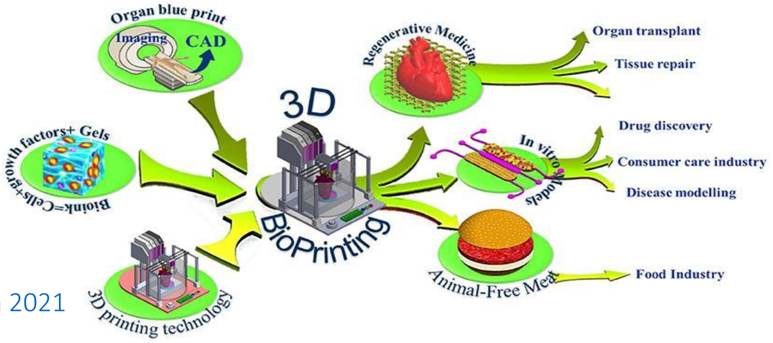
commercialization

Drug repurposing

Metformin: From Curing Diabetes to Radioprotection

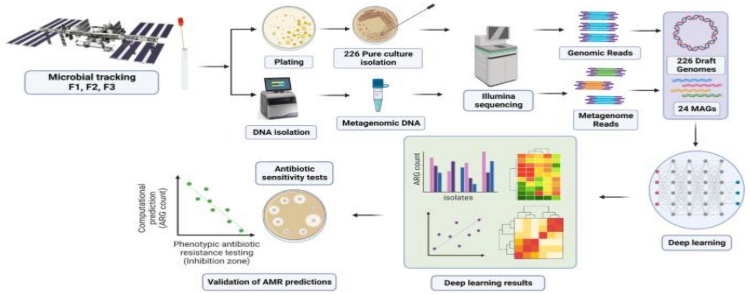
Siteni et al., 2024

Biofabrication



Ramadan 2021

Microbiome and antimicrobial research



Madrigal et al., 2022

Human exploration on Earth and in space: Its impact on medicine

Commercial players

Success story

MERCK

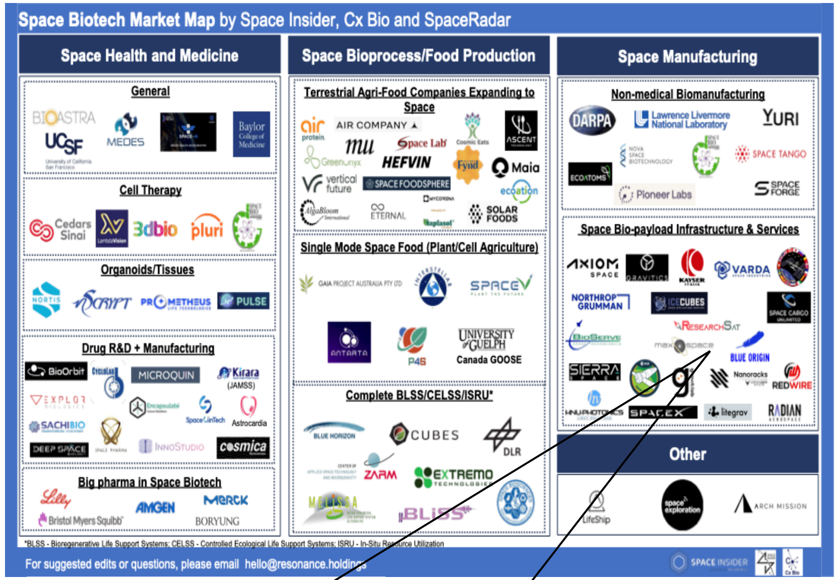
KEYTRUDA

Use: FDA approved drug for immunotherapy

Nature of molecule: Monoclonal antibody

Type: Biologics

Space Insider 17 June 2024

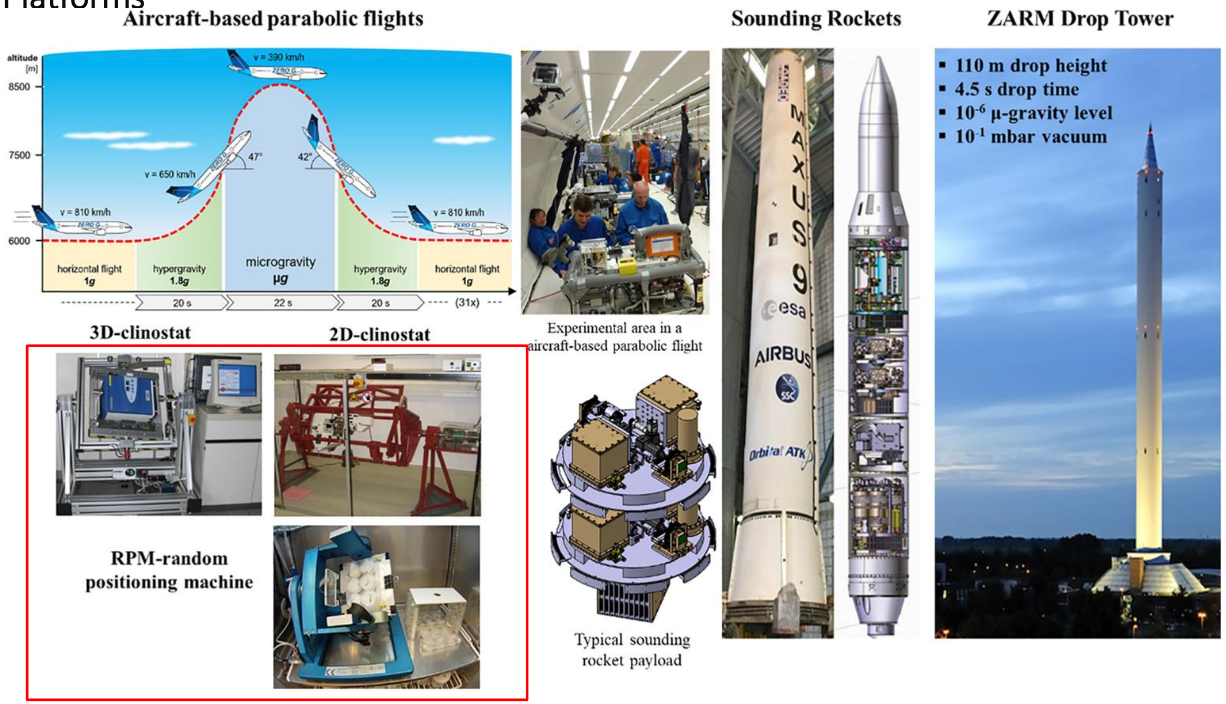


RESEARCHSAT
Satellites for Life-Sciences

Human exploration on Earth and in space: Its impact on medicine

How and where one can perform experiments in microgravity both on Earth and beyound?

Platforms

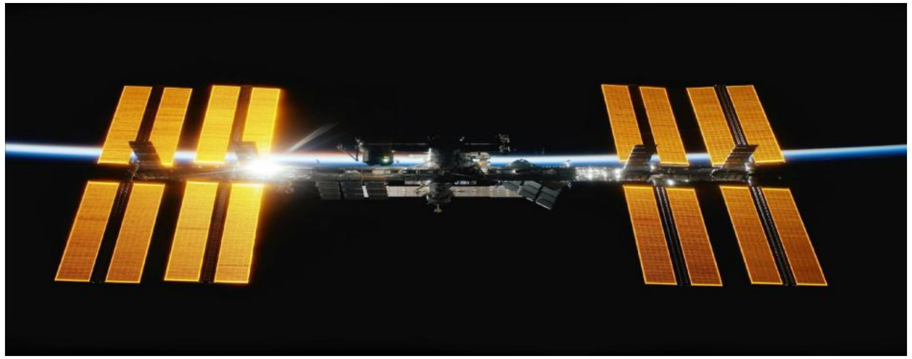


Prasad et al., 2020

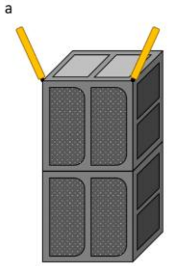
Short term real and simulated microgravity

Prasad et al., 2020

ISS



Small satellite (Cube sat)

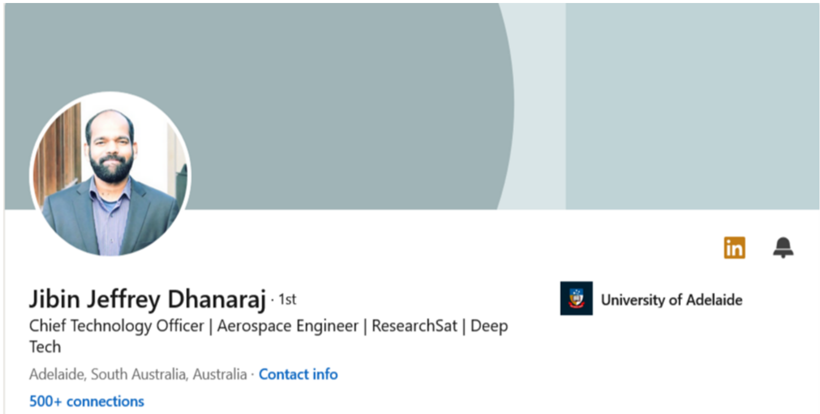


Ferranti et al., 2021

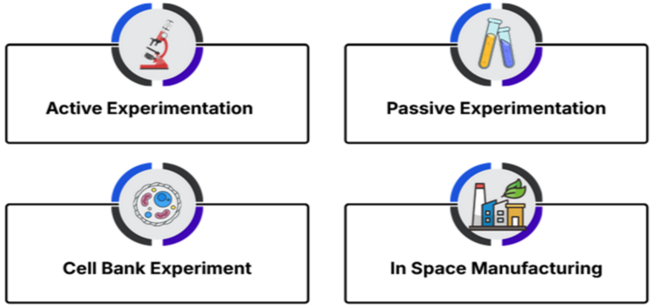
Long term Real microgravity

Human exploration on Earth and in space: Its impact on medicine

Do you have the next big idea to transform human health through space?



Person of interest (POI)



A range of research experiment options, all-inclusive of end-to-end services

Human exploration on Earth and in space: Its impact on medicine

Conclusion and outlook

kardashev.fandom.com

Thank You

Beyond Earth, Beyond Limits

Antariksh Parichha

Co-Founder & CEO, Serendipity Space

MISSION

Accelerate drug development on Earth by processing pharmaceuticals in microgravity.

We are building small reusable satellites to process pharmaceuticals in Low Earth Orbit, and bring them back to Earth.

SERENDIPITY SPACE

THE STATUS QUO

Drug Development on Earth takes painfully long and costs billions of dollars.

- Time : 10-15 years to develop a new drug.*
- Cost : $2 Billion - $3Billion USD per drug.
- Failure rate : 90%

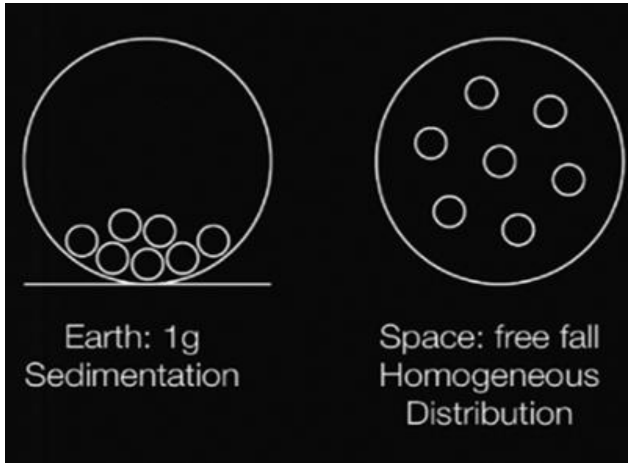
*Why 90% of clinical drug development fails and how to improve it?

THE PROBLEMS

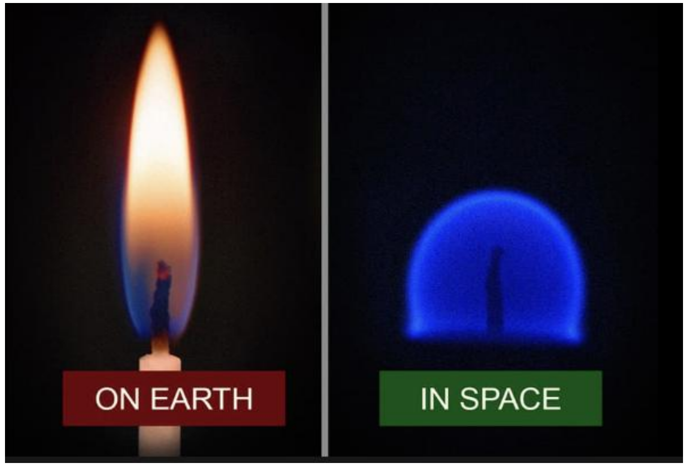
- Unsuccessful crystallization.
- Non-uniform particle size and poor solubility.
- Low quality formulations, high viscosity for high concentration doses.
- Repeated trial and error for years.

INDUSTRY SECRET: SPACE AS A PLATFORM FOR PHARMA

No Sedimentation

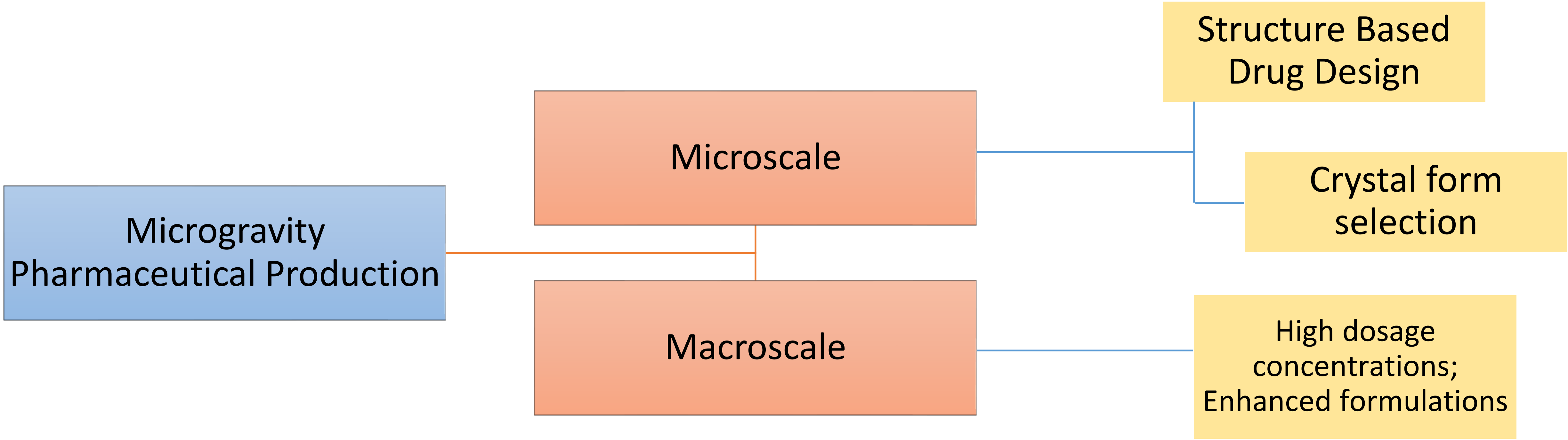


No convection currents

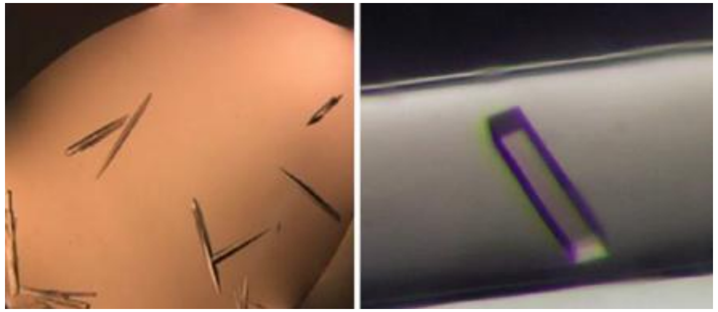


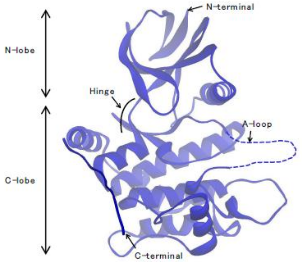
No buoyancy

THE VALUE CHAIN



COMMERCIAL SUCCESSES : STRUCTURE BASED DRUG DESIGN





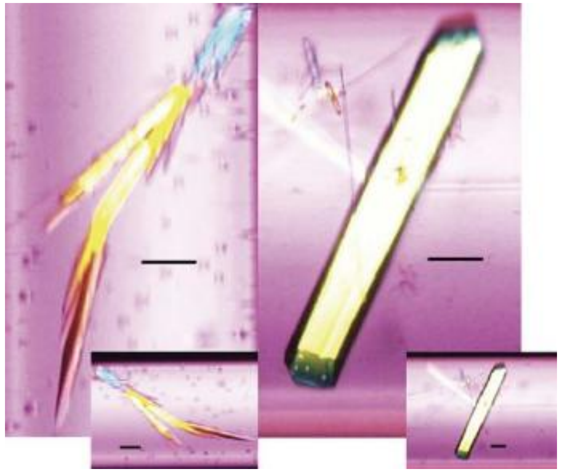
Carna Biosciences

MAP2K7 Protein

1.3 Å obtained from space, solved structure based design, identified novel inhibitors.

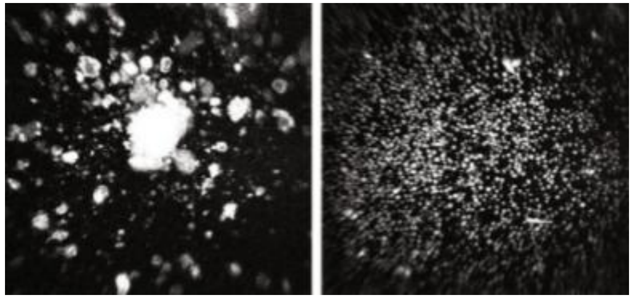
COMMERCIAL SUCCESSES : STRUCTURE BASED DRUG DESIGN

Taiho Pharma



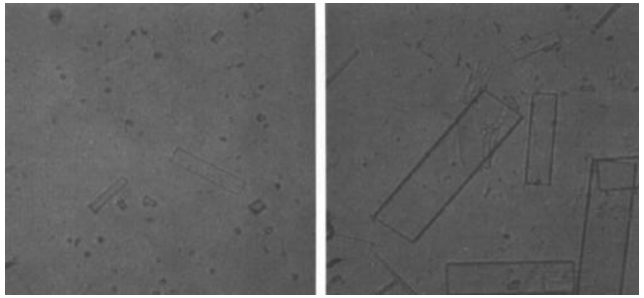
- Drug development enabled by co-crystallization of **H-PGDS** with drug molecule. Discovered novel inhibitor.
- Drug now in Phase III CT.

COMMERCIAL SUCCESSES : MACROSCALE PRODUCTION



Merck's Keytruda

Crystalline suspension for SC administration, recreated a version on Earth, in Phase III CT.



Schering Plough's Interferon alpha

Crystalline suspension for SC administration, tested in Cyn. Monkeys. Stable formulation for over 2 years.

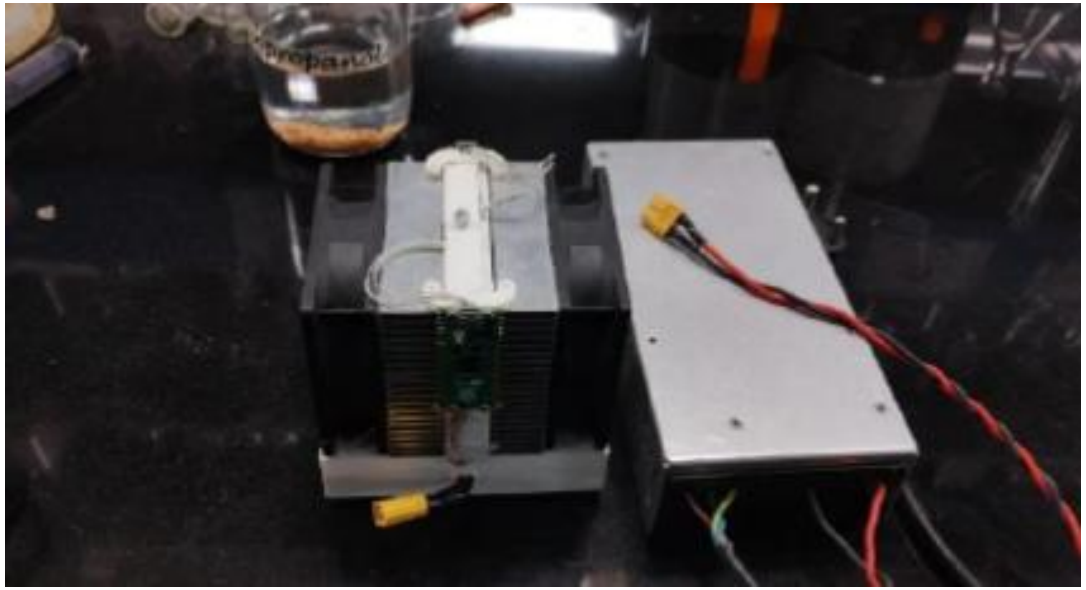
THE ALCHEMY BOX : STRUCTURE BASED DESIGN

PROTEIN AND SMALL MOLECULE CRYSTALLIZATION

AUTONOMOUS PRODUCTION IN SPACE & RETURN TO EARTH

SCALABLE TO MULTIPLE SAMPLES

THE ALCHEMY BOX : FORMULATIONS

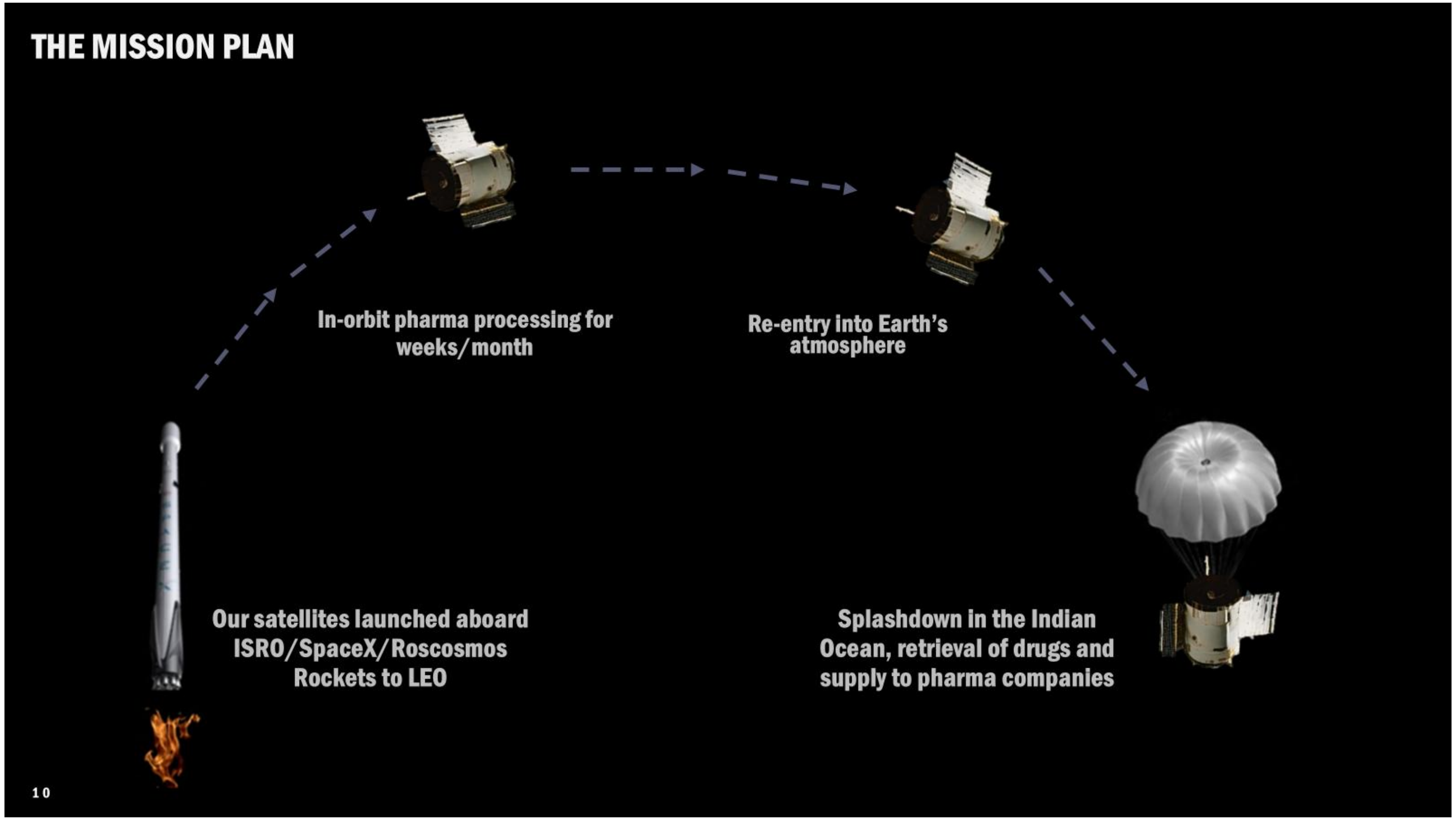


BATCH CRYSTALLIZATION AND PARTICLE SIZE CONTROL

AUTONOMOUS PRODUCTION IN SPACE & RETURN TO EARTH

SCALABLE TO KG SCALES

MISSION PLAN



MEET THE TEAM

Jivitesh Debata

CTO, CO-FOUNDER

M.Sc. Robotics & AI @ Rochester Inst. Technology, USA

Automation & manufacturing @ Serendipity Space

Dr. Monica Ekal

Chief of Space Systems, CO-FOUNDER

Ex-NASA & Scientist @ German Aerospace Center, Ph.D. Univ. of Lisbon

Mission planning, re-entry, and in-space operation @ Serendipity Space

Chief of Space Systems

Antariksh Parichha

CEO, CO-FOUNDER

M.Sc. Applied Physics @ TUM, Germany; Ex-Hyperloop, Winner SPRIN-D & U.S. D.o.D Grants

Business development & tech roadmap @ Serendipity Space

ADVISORS

Dr. Subhabrata Sen, FRSC

Scientific Advisor, Pharmaceuticals

Fellow of Royal Society of Chemistry, London

- Ex-Senior & Scientific Manager at Syngene & Pfizer India
- Ex-Associate Director at GVK Bio

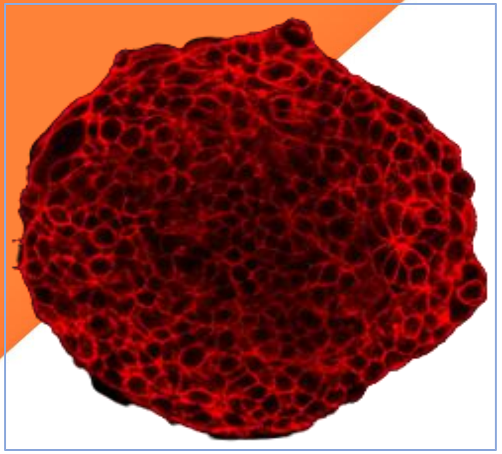
Dr. Parthapratim Munshi, FRSC

Scientific Advisor, Crystallization

Fellow of Royal Society of Chemistry, London

- Scientist at Oak Ridge National Lab for Protein Crystallography
- Ex-Associate Director at GVK Bio

Thank You



Impact of off-world studies on clinical practices on Earth

Suresh Poosala
DVM MS PhD

INTRODUCTION

Accelerating Translation

Antibodies
Peptides
Cells

Vaccines

Fibrosis model
NAFLD

Oncolytic Virus
Organoids
Immune Tumoroid

From Cell lines and Patient derived primary cells

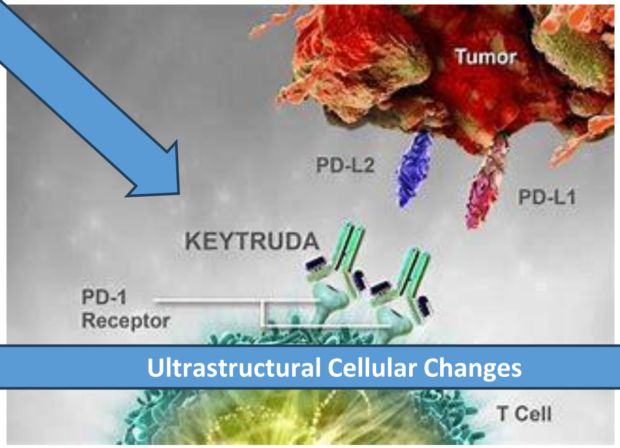
NCEs, Biologics, Cells, Genes etc.,

KEYTRUDA®
(pembrolizumab)

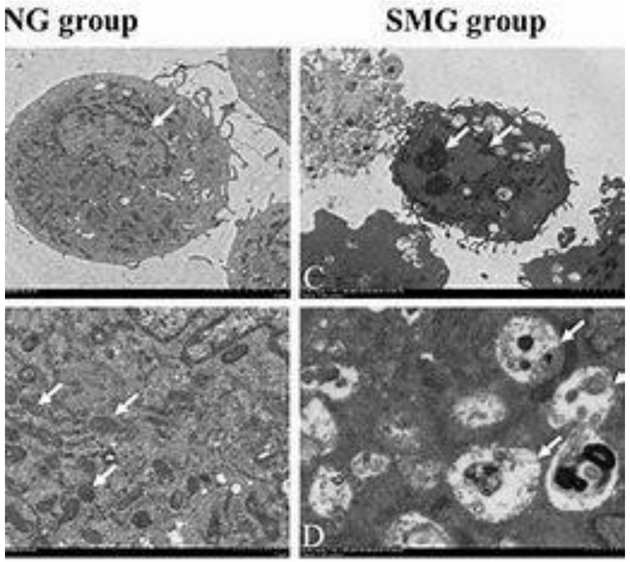
Key Insights on Keytruda Research in Microgravity

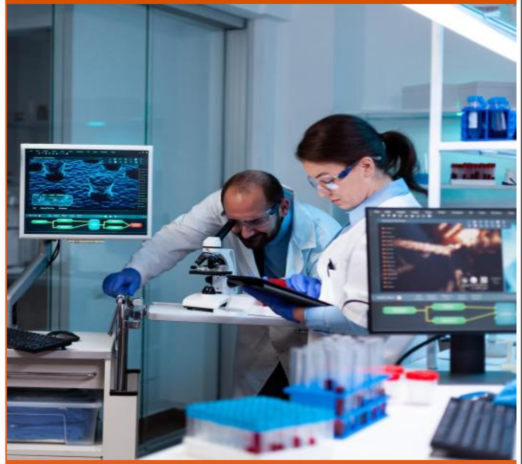
1. **Understanding Antibody Functionality**:
   - Microgravity environments alter the way antibodies like Keytruda behave.
   - For instance, growing larger and more stable protein crystals in space provides clearer insights into the binding sites of antibodies & interactions with cancer cells.

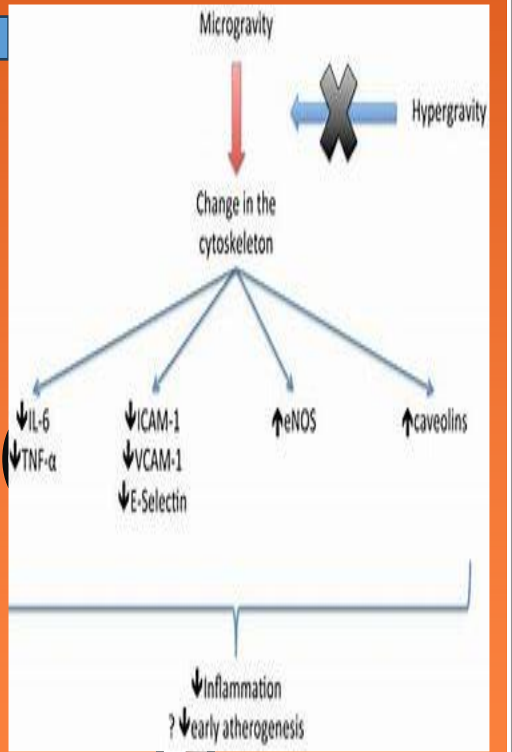
2. **Enhanced Drug Efficacy Studies**:
   - Microgravity research provides unique insights into cell behavior.
   - Researchers can understand how these cells respond to therapies.

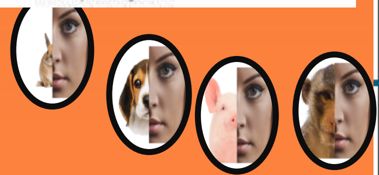


Ultrastructural Cellular Changes

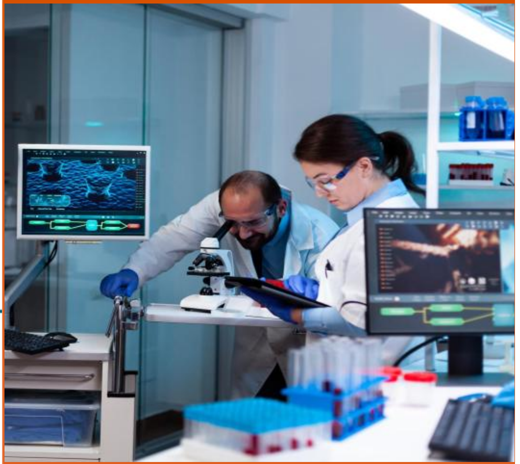






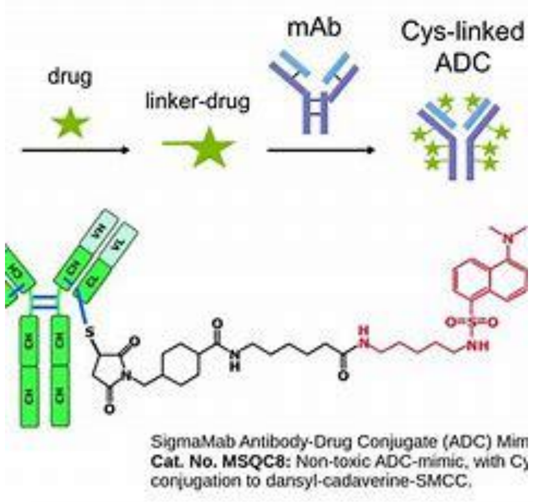


Key Insights on Keytruda Research in Microgravity

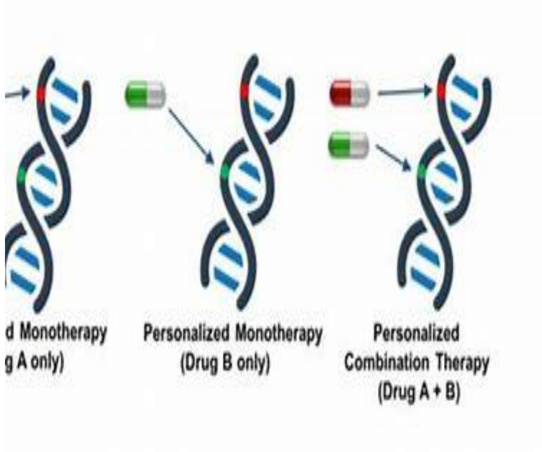


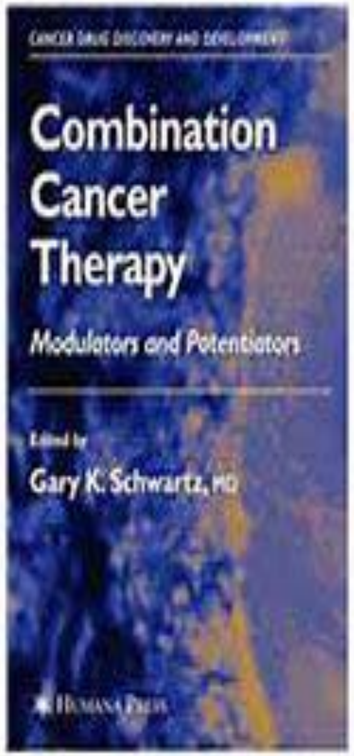
1. **Development of Combination Therapies**:

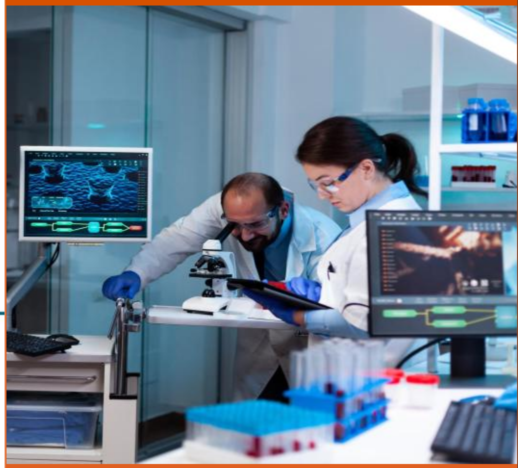
   - Microgravity affects the interaction between Keytruda + other NCEs.



   - Development of combination therapies that enhance the effectiveness of cancer treatments.



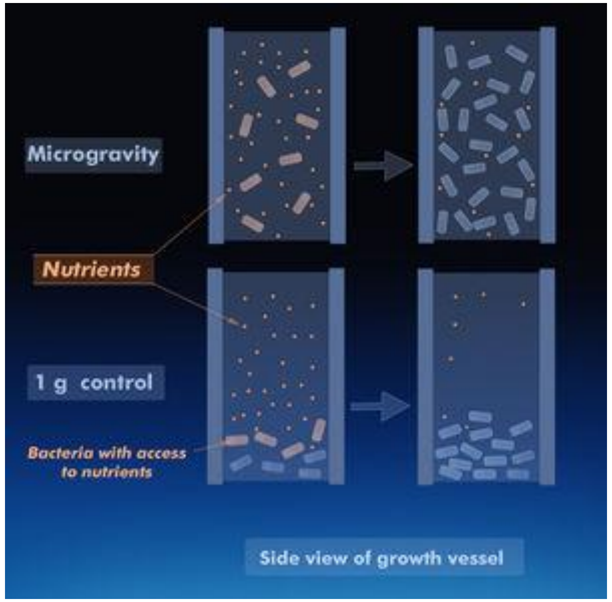


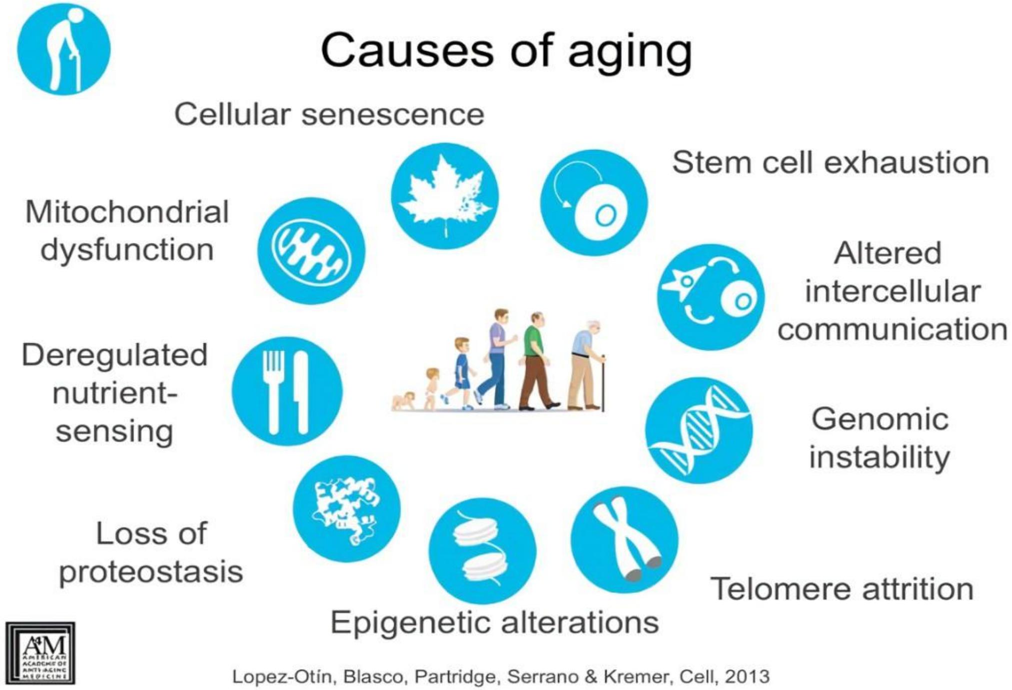


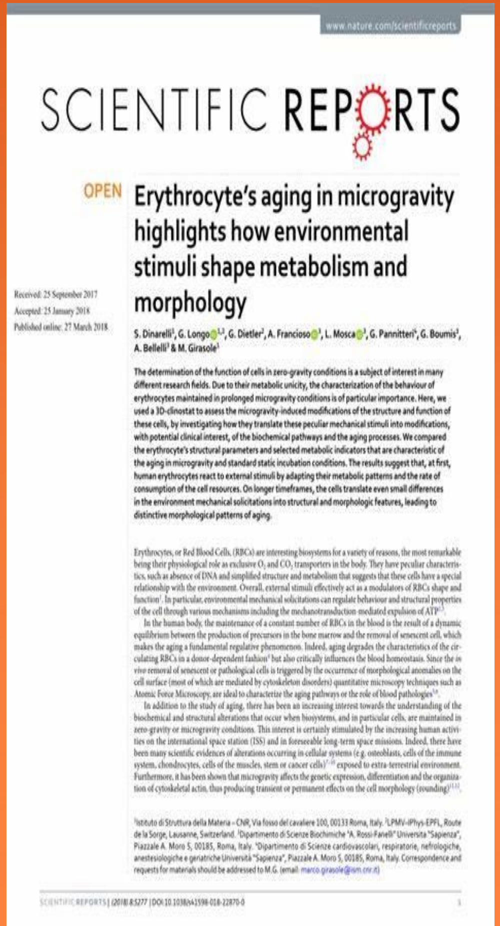
Key Insights on Keytruda Research in Microgravity

Monitoring Cellular Changes:

Studies have shown that microgravity can lead to accelerated aging in cellular processes (reversible!). By using Keytruda as part of research into these processes, scientists investigated how microgravity impacts the immune response and the effectiveness of immunotherapy in aging.







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SCIENTIFIC REPORTS

OPEN

Erythrocyte's aging in microgravity highlights how environmental stimuli shape metabolism and morphology

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S. Dinarelli[1], G. Longo[1,2], G. Dietler[2], A. Francioso[3], L. Mosca[3], G. Pannitteri[4], G. Boumis[3], A. Bellelli[3] & M. Girasole[1]

The determination of the function of cells in zero-gravity conditions is a subject of interest in many different research fields. Due to their metabolic unicity, the characterization of the behaviour of erythrocytes maintained in prolonged microgravity conditions is of particular importance. Here, we used a 3D-clinostat to assess the microgravity-induced modifications of the structure and function of these cells, by investigating how they translate these peculiar mechanical stimuli into modifications, with potential clinical interest, of the biochemical pathways and the aging processes. We compared the erythrocyte's structural parameters and selected metabolic indicators that are characteristic of the aging in microgravity and standard static incubation conditions. The results suggest that, at first, human erythrocytes react to external stimuli by adapting their metabolic patterns and the rate of consumption of the cell resources. On longer timeframes, the cells translate even small differences in the environment mechanical solicitations into structural and morphologic features, leading to distinctive morphological patterns of aging.

Erythrocytes, or Red Blood Cells, (RBCs) are interesting biosystems for a variety of reasons, the most remarkable being their physiological role as exclusive O_2 and CO_2 transporters in the body. They have peculiar characteristics, such as absence of DNA and simplified structure and metabolism that suggests that these cells have a special relationship with the environment. Overall, external stimuli effectively act as a modulators of RBCs shape and function[1]. In particular, environmental mechanical solicitations can regulate behaviour and structural properties of the cell through various mechanisms including the mechanotransduction-mediated expulsion of ATP[2,3].

In the human body, the maintenance of a constant number of RBCs in the blood is the result of a dynamic equilibrium between the production of precursors in the bone marrow and the removal of senescent cell, which makes the aging a fundamental regulative phenomenon. Indeed, aging degrades the characteristics of the circulating RBCs in a donor-dependent fashion[4] but also critically influences the blood homeostasis. Since the in vivo removal of senescent or pathological cells is triggered by the occurrence of morphological anomalies on the cell surface (most of which are mediated by cytoskeleton disorders) quantitative microscopy techniques such as Atomic Force Microscopy, are ideal to characterize the aging pathways or the role of blood pathologies[5,6].

In addition to the study of aging, there has been an increasing interest towards the understanding of the biochemical and structural alterations that occur when biosystems, and in particular cells, are maintained in zero-gravity or microgravity conditions. This interest is certainly stimulated by the increasing human activities on the international space station (ISS) and in foreseeable long-term space missions. Indeed, there have been many scientific evidences of alterations occurring in cellular systems (e.g. osteoblasts, cells of the immune system, chondrocytes, cells of the muscles, stem or cancer cells)[7-10] exposed to extra-terrestrial environment. Furthermore, it has been shown that microgravity affects the genetic expression, differentiation and the organization of cytoskeletal actin, thus producing transient or permanent effects on the cell morphology (rounding)[11,12].

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Pembrolizumab microgravity crystallization experimentation

Paul Reichert1*, Winifred Prosise1, Thierry O. Fischmann1, Giovanna Scapin1, Chakravarthy Narasimhan2, April Spinale3, Ray Polniak4, Xiaoyu Yang5, Erika Walsh2, Daya Patel5, Wendy Benjamin2, Johnathan Welch5, Denarra Simmons6 and Corey Strickland1
1234567890()

The research laboratories of Merck (MSD) in collaboration with the International Space Station (ISS) National Laboratory performed crystallization experiments with pembrolizumab (Keytruda®) on the SpaceX-Commercial Resupply Services-10 mission to the ISS. By leveraging microgravity effects such as reduced sedimentation and minimal convection currents, conditions producing crystalline suspensions of homogeneous monomodal particle size distribution (39 µm) in high yield were identified. In contrast, the control ground experiments produced crystalline suspensions with a heterogeneous bimodal distribution of 13 and 102µm particles. In addition, the flight crystalline suspensions were less viscous and sedimented more uniformly than the comparable ground-based crystalline suspensions.

These results have been applied to the production of crystalline suspensions on earth, using rotational mixers to reduce sedimentation and temperature gradients to induce and control crystallization. Using these techniques, we have been able to produce uniform crystalline suspensions (1–5 µm) with acceptable viscosity.

Microgravity: A Tool for Protein Drug Development

JohnPaul O. Enemali et al.,

Protein crystals developed in microgravity can produce substantively superior structural information than can be acquired from crystals yielded on Earth.

Absence of sedimentation which prevents protein crystals from plummeting to the bottom of the containers on which they are grown as they do on their counterpart ground condition.

Also, **convective flows are also greatly reduced in microgravity** and so crystals grown in a much more inert environment yield better quality.

Therefore, space is an **excellent environment** to study complex, three-dimensional proteins.

Through this effort, **more concentrated and high-quality mixtures** that can be administered to patients more efficiently are developed as drugs

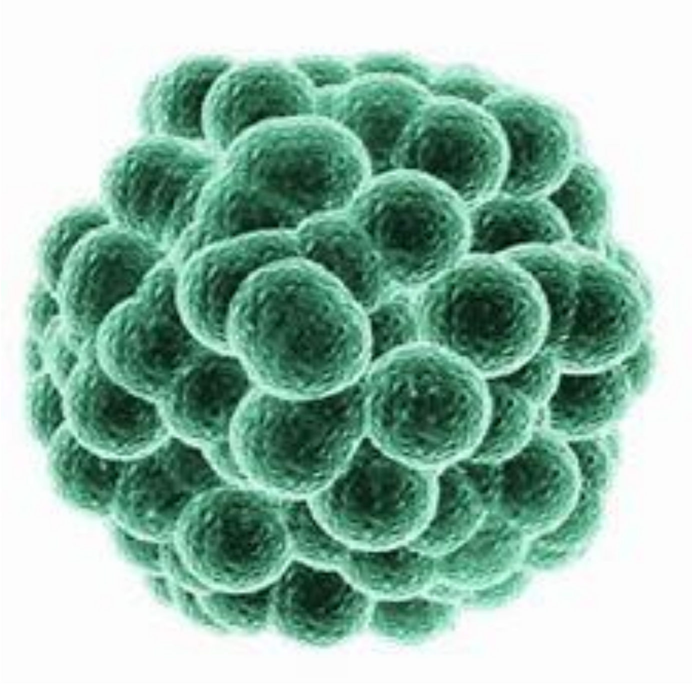
Microgravity

Direct

- No surface attachment
- Cells tend toward spherical shape unless previously attached to a surface
- Disorganization of MTOC's (microtubule organizing centers)
- Membrane lipid raft changed
- Transmembrane signalling for some receptor mediated activities
- Induction of differentiation
- Delay in onset or inhibition of apoptosis
- Inhibitition of locomotory activity
- Potential exaggeration of cell-cell rather than cell-substratum interaction

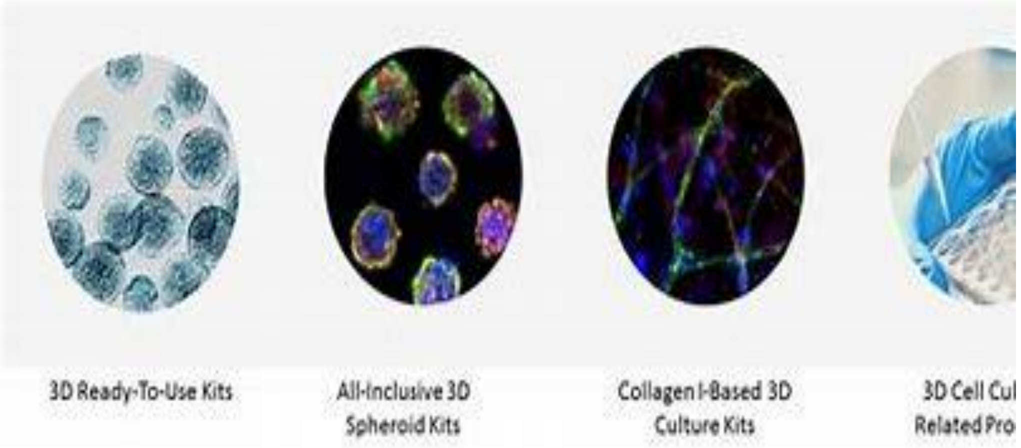
3D Cell Culture in Microgravity

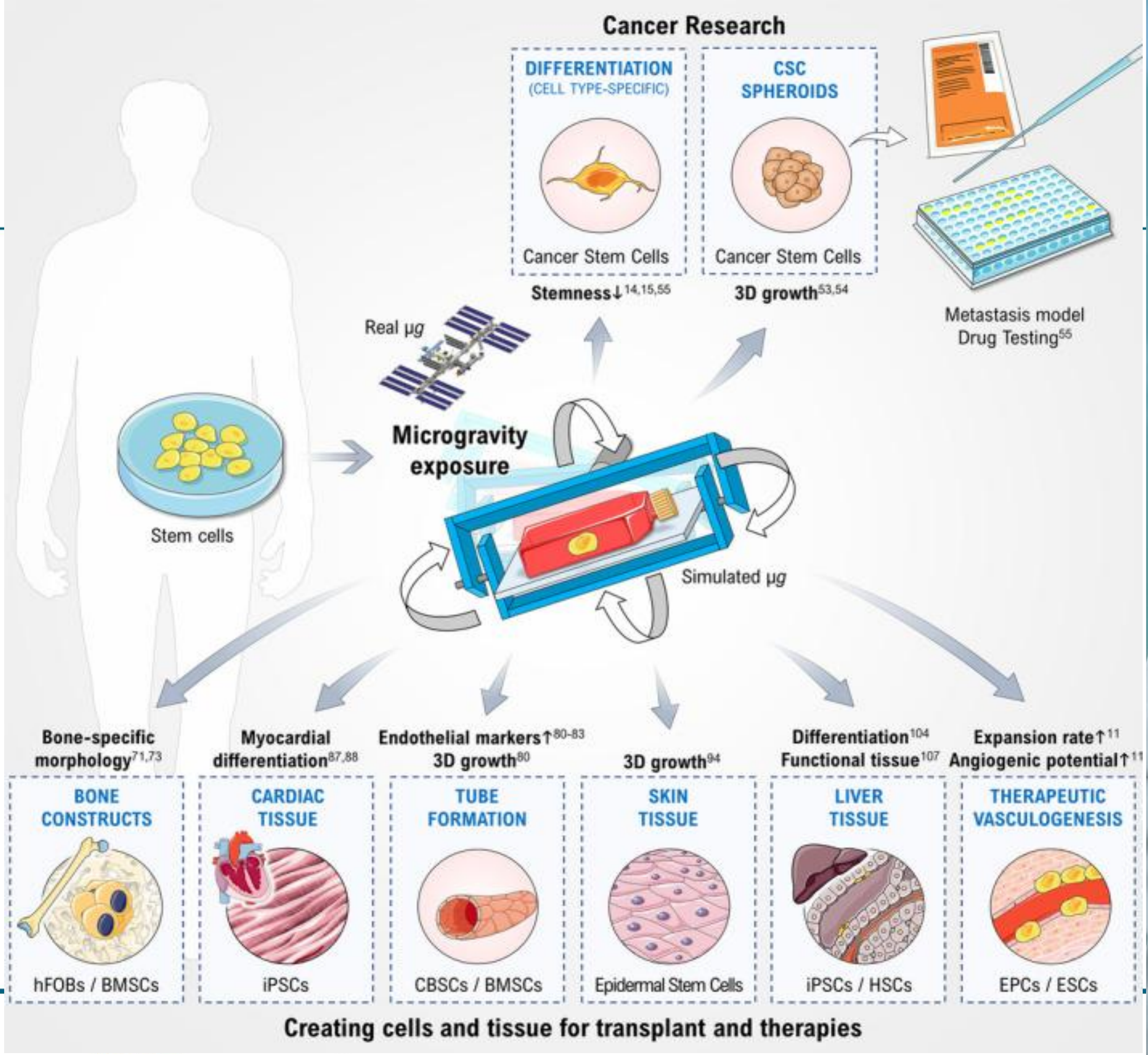
- In microgravity, cells can grow in three-dimensional structures, more closely resembling their natural environment.
- This 3D cell diseaseculture system provides more accurate models for studying mechanisms and testing drug responses.



Key Insights:

- Microgravity-induced 3D cell cultures mimic human tissue architecture, enhancing the relevance of experimental results.
- These models are particularly useful for studying complex diseases and evaluating the efficacy of biologic drugs.
- The ISS hosts experiments that utilize microgravity to develop and test 3D cell culture systems for biomedical research.

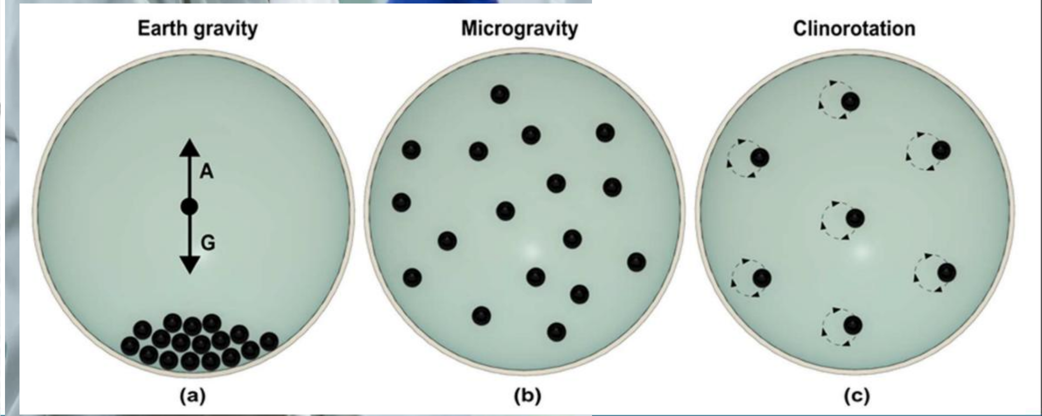




FEATURES AND BENEFITS

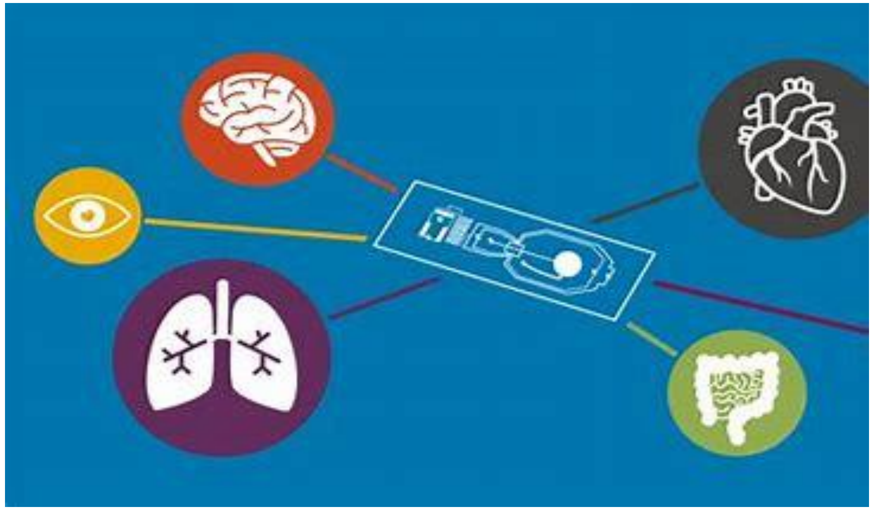
We aim to help the Pharma R&D take

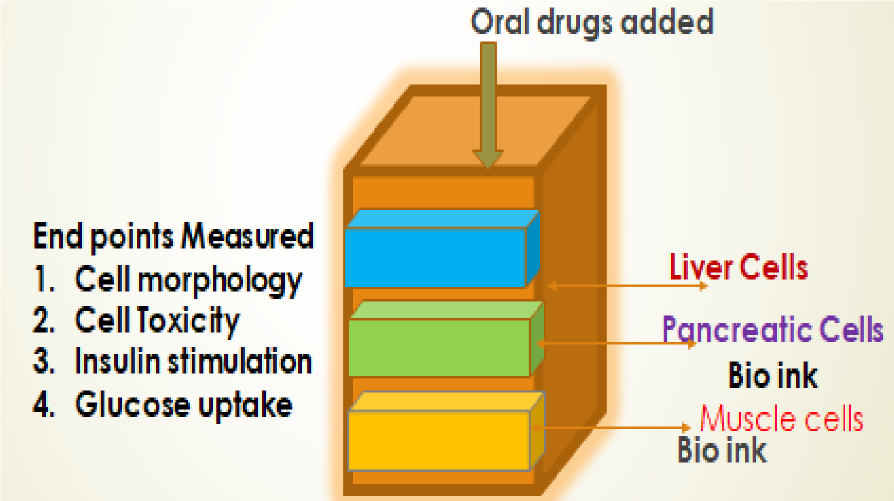
informed decisions



OUR FUTURISTIC VERTICAL THAT IS TO BE EXPLORED IS PERSONALIZED CANCER TREATMENT USING PATIENT SOURCED BIOPSY OF SOLID TUMORS

New Initiatives in our Lab that we are open for Space Microgravity Exploration Research





We have 3D printing capabilities in R&D phase in partnership with Reagene Bio.

We are venturing into Microphysiological Systems (MPS or Organ-on-a-Chip) now.

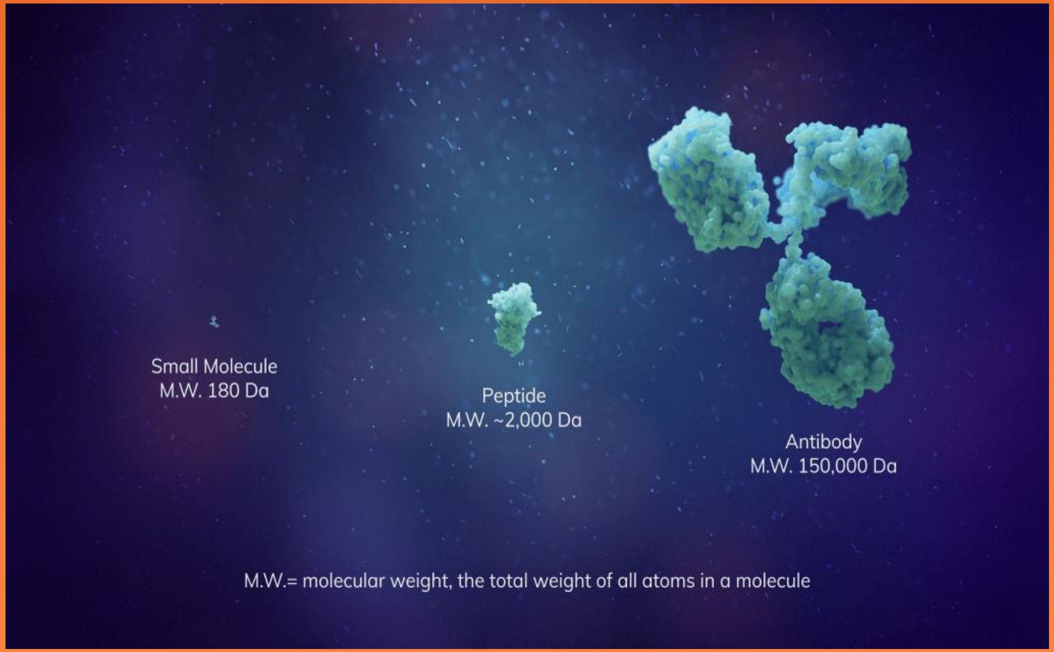
Who's Doing It?

Several organizations are leading efforts in creating biologics in space:

•**NASA** and **ISS National Lab** support biotech R&D in space.

•**Merck**, **Boehringer Ingelheim**, and **Axiom Space** have explored drug development on the ISS.

•Startups like **Varda Space Industries** aim to manufacture biologics in orbit.



Future Possibilities

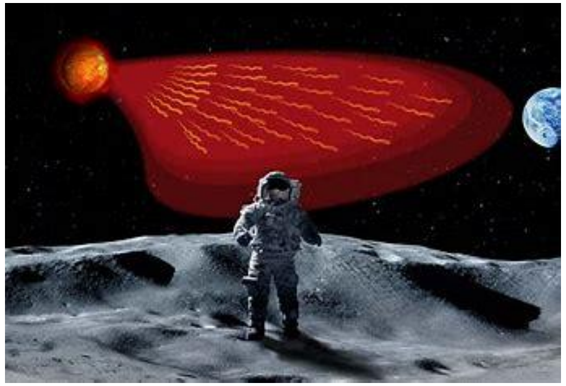
- Space-grown **personalized medicines**
- AI + microgravity-based **target discovery pipelines**
- **Biomanufacturing** in orbit for ultra-pure biologics

Conducting biomedical research in space presents several challenges

1. Technical Limitations
    - **Equipment and Instrumentation**: Cost of Transportation
    - **Limited Access to Resources**: Hinders experimental flexibility and replication efforts.

2. Environmental Control
    - **Microgravity Conditions**: Fluctuations can occur due to spacecraft movements or operational activities.
    - **Radiation Exposure**: Can affect biological samples and limit the duration of certain experiments.

3. Biological Variability
    - **Unpredictable Cellular Responses**: Cells can behave differently in microgravity
    - **Replication Challenges**: Due to the unique conditions, replicating experiments consistently is challenging.



- **Logistical Constraints**
- **Crew Time Limitations**: Astronauts have limited time available for scientific experiment.
- **Communication Delays**: Latency in communication with Earth.

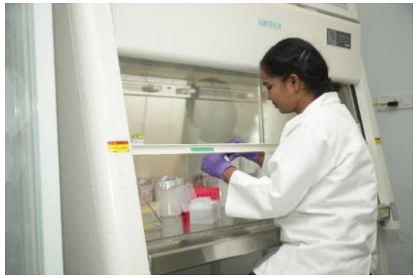
These challenges require innovative solutions and careful planning but also highlight the exciting potential of conducting research in microgravity environments, such as the ISS.

TEAM IN ACTION

Flouresence & Confocal Microscopy

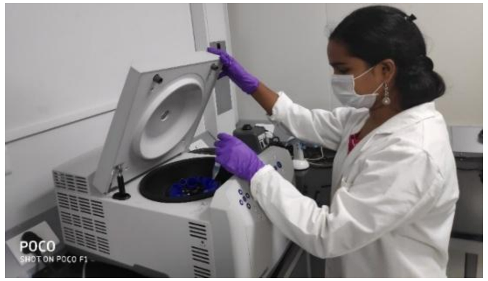
Biosafety level 2 Grade Cell Culture Rooms

-80, -20, and 4 degrees refrigerators



Biosafety Cabinets

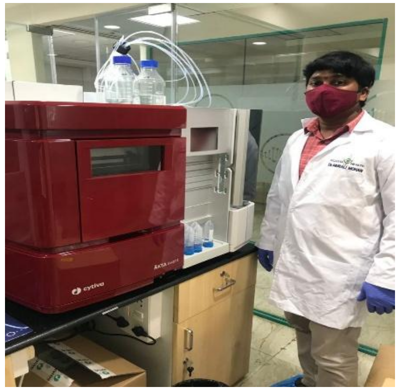
Liquid Nitrogen Tanks



Cold Centrifuge

Multi Mode Plate Reader

CO2 incubators



AKTA Cytiva

FACS CytoFlex

Image express

ACASTA HEALTH

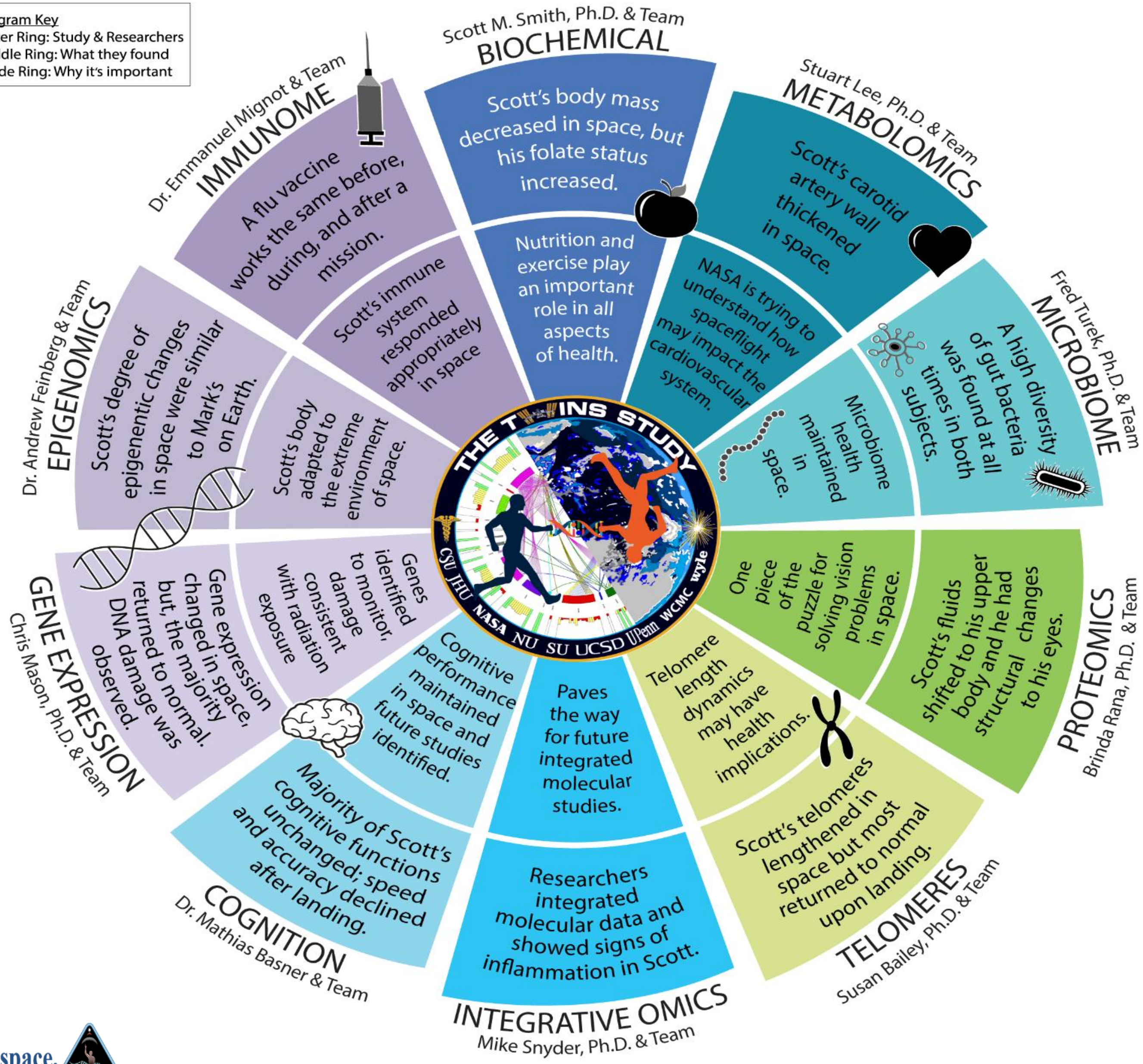
Thank You

EXPLORE HUMANS in SPACE

TWINS STUDY RESULTS AT A GLANCE:

What They Found and Why it's Important

Diagram Key
Outer Ring: Study & Researchers
Middle Ring: What they found
Inside Ring: Why it's important



NASA's Twins Study revealed interesting and assuring data on how a human adapted to space.

Dr. Suresh Poosala
DVM MS PhD

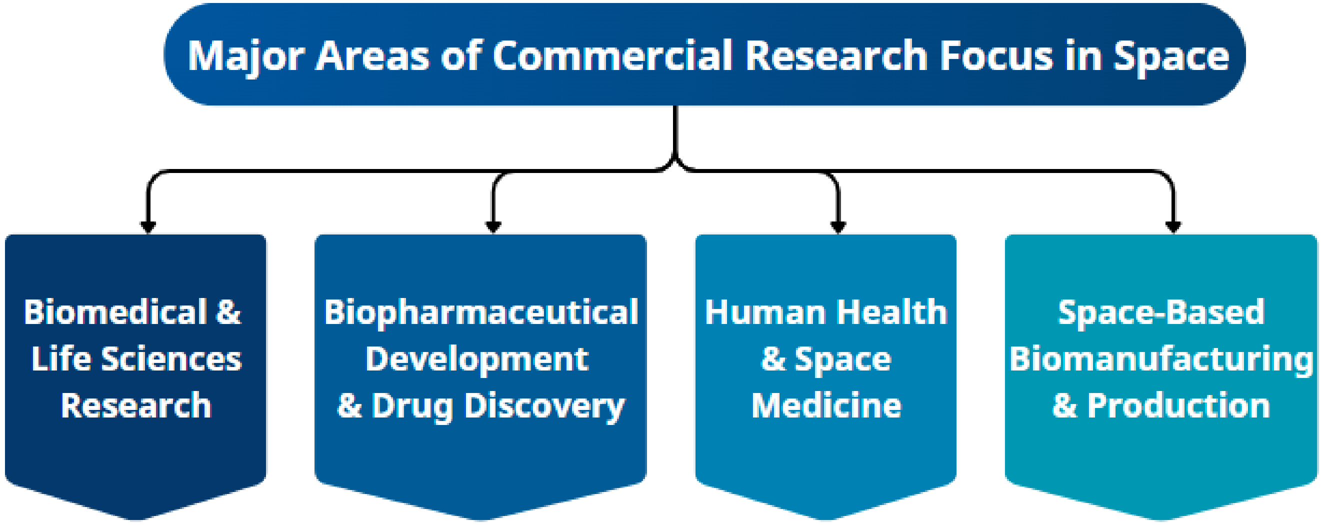
ResearchSat
Satellites for Life-Sciences

Microgravity Research

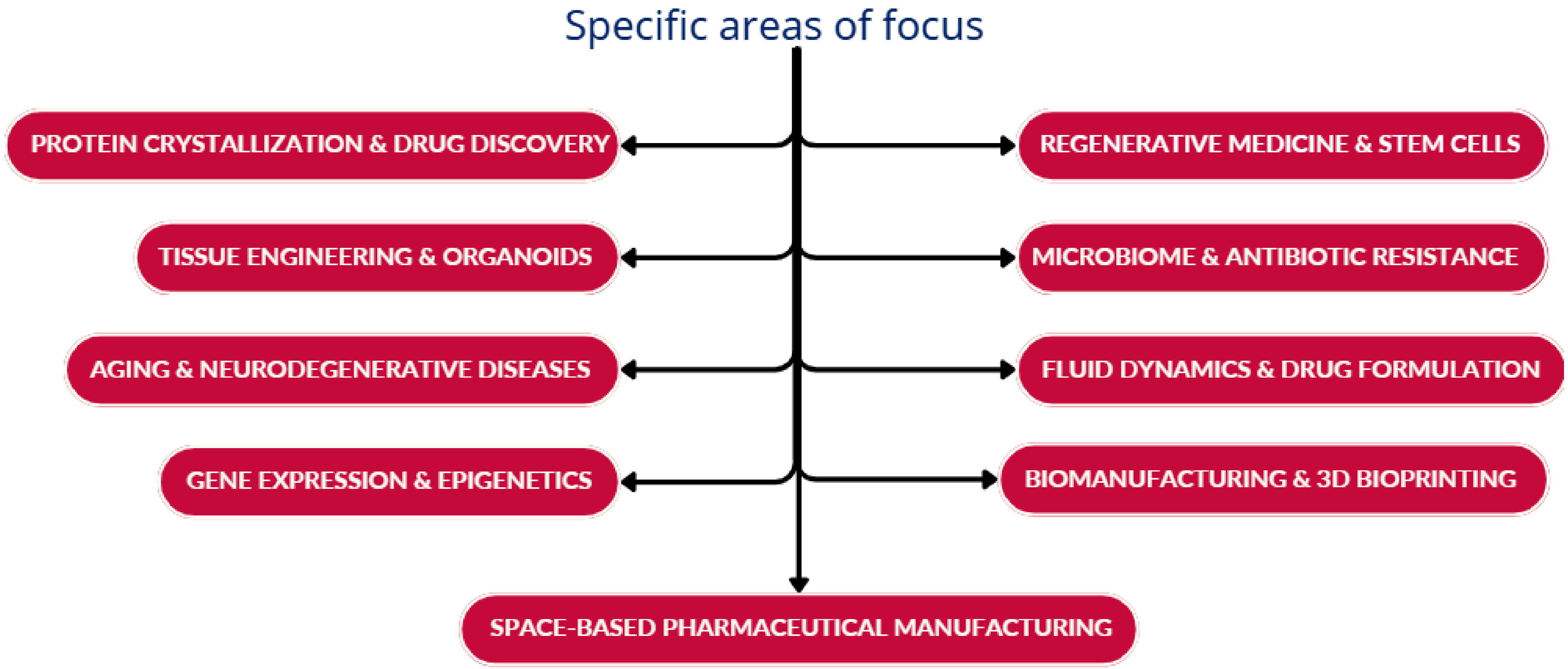
A Strategic Frontier for Pharma & Biotech Innovation

Major Undertaking by Global Industries

The pharma/biotech industry is entering a transformative era where space-based research is unlocking solutions that were once thought impossible. Pharmaceutical companies mostly from US & Europe, have ventured to utilise the uniqueness of microgravity environment and discovered significant boost to their scientific and commercial activities for new therapeutic development.



Major Areas of Commercial Research Focus in Space



Over the last 27 years, nearly 3700 experiments have been conducted aboard the ISS with roughly 45% focused on Life Sciences Industry

Major Undertaking by Global Industries

Commercial Research

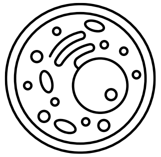
MERCK, NOVARTIS, AMGEN, AstraZeneca, Lilly, Angiex, emulate, BORYUNG Pharmaceutical, MICROQUIN, GILEAD, Cedars Sinai, pluri

Fundamental Research

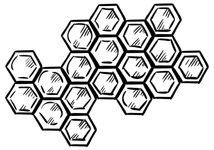
NASA, esa, DLR, JAXA, BioServe Space Technologies, Baylor College of Medicine, UF University of Florida, Mayo Clinic, UC San Diego, UCLA

Major Players in Microgravity Research

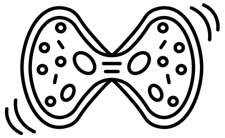
Scientifically Validated Effects of Microgravity



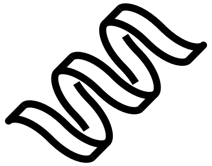
Cell Shape & Morphology



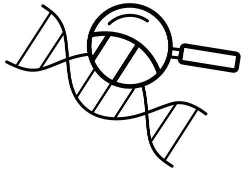
Cell Adhesion & Extracellular Matrix



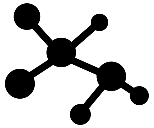
Cell Division & Proliferation



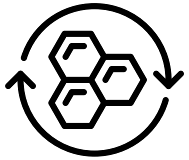
Protein Production



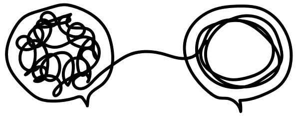
Gene Expression



Fluid Dynamics & Transport



Cytoskeletal Rearrangements



Microgravity Induced Stress

About us

ResearchSat
Satellites for Life-Sciences

We are an aerospace engineering & manufacturing company specializing in design & development of cutting-edge payloads & satellites for scientific research. Our mission is to enable life-saving therapeutics and advance scientific knowledge through high-cadence and accessible microgravity research.

- Turnkey Solutions: Designing and deploying scientific payloads tailored to specific experimental needs for spaceflights
- Launch Support: Seamless integration with ISS & LEO launch partners globally
- Mission Operations: Autonomous experiment management and real-time data streaming from launch to return of payloads back to Earth
- Post-Mission Deliverables: Sample retrieval and comprehensive data analysis

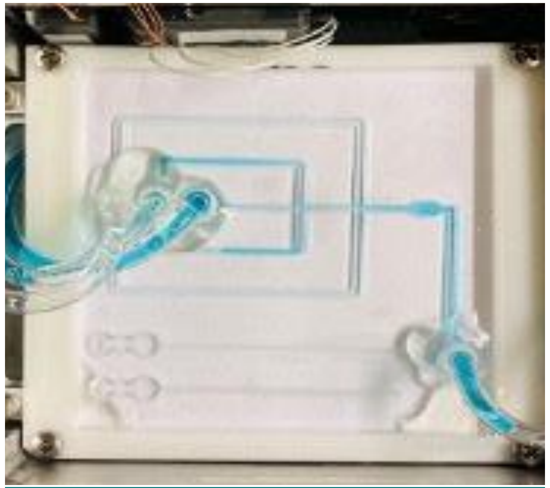
Introducing ADI-Lab, the cutting-edge space bioreactor transforming drug development and manufacturing in space

ADI-LAB

SPACE

MICRO-HABITAT

Protein Crystallisation 3D Cell Research



SPACE

FLUIDIC Platform

Drug Delivery Research | Drug Discovery

SPACE

FLUID REACTOR

Centrifuge, Mixer, Vortexer

ADI-Lab

ADI-Lab is a satellite platform with experimental chambers known as Space Micro Incubator (SMI) and Space Fluidic Platform (SFP).

Within SMI & SFP, a wide range of experiments can be performed including:

- protein crystallisation
- 3D cell research including organoids & organ-on-a-chip
- drug discovery, drug stability & drug delivery research
- plant growth studies

To complement satellite operations, we have an in-house developed flight computer, advanced sensor suite and data acquisition systems all with successful space heritage.

Our Product Specifications

Advanced Microfluidic Chip for:

- Fungi, Bacteria, Tissue Cell culture assays
- Organs & complex systems on a chip
- Macro Double emulsion generator
- Protein Crystallization Chambers

Multiplatform Integration:

- Integrated within orbital platforms like the ISS, suborbital rocket modules & host satellites
- Imagery & Data Transmission enabled for the duration of the experiment
- Modular & Scalable in Size & Weight

Advanced Protection Systems:

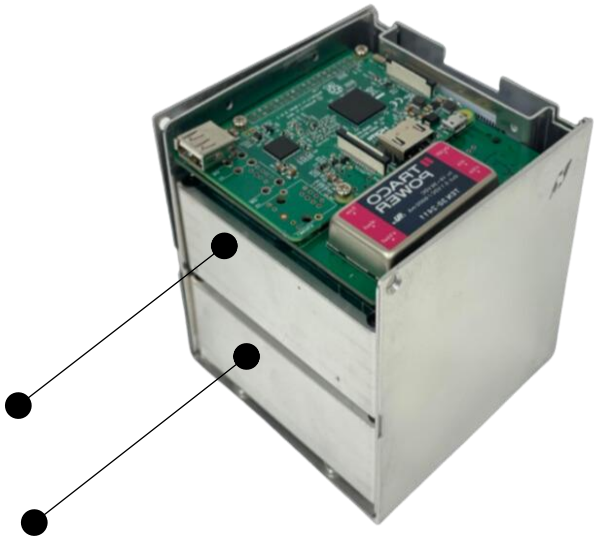
- Advanced Insulation material coatings
- Fail-Safe & Safe-Fail systems (In-built into design)
- Controlled Space Environment experiments (Fully insulated & partially insulated Research)

Standard Size & Weight

- Designed on a 1U CubeSat form factor (10x10x10 cm) and weight of 1kg
- Multiple experiments can be autonomously run on the same flight

AI Controlled Sensor Suite:

- Thermal Management
- Power management
- Radiation, pressure monitor
- Reliable communication



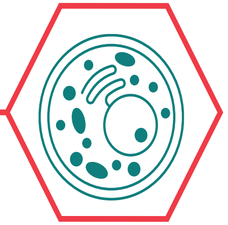
Space Micro Incubator (SMI)

Space Fluidic Platform (SFP)

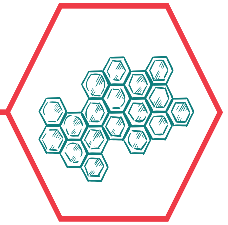
SPACE Micro-Incubator (SMI)

Protein Crystallisation |Stem Cell | 3D Cell Research

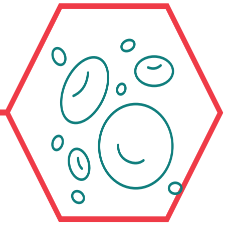
DEMONSTRATED CAPABILITIES



Cell Viability including incubation, growth & storage



3D Cell structure growth | Biofilm formation



Physiological & Morphological Changes

CELL HEALTH & GROWTH MONITORING

- Camera with 400-800x magnification
- x/y axis motion to capture images
- Spectrophotometer in UV, IR and VIS spectrum

ENVIRONMENTAL CONTROL & MONITORING

- Temperature and humidity regulation
- CO_2 & O_2 concentration regulation
- pH control unit, Glucose & Lactate Sensor

AUTOMATED MEDIA EXCHANGE & WASTE REMOVAL

- Advanced Microfluidic chip hosting living cells
- Micropumps integrated with reservoirs for media removal

SPACE Fluidic Platform (SFP)

Drug Delivery | Drug Discovery | Chemistry

DEMONSTRATED CAPABILITIES

Multi Fluid Control

Complex Fluidic Dynamics

Multiple Emulsions

EXPERIMENT GROWTH MONITORING

- 8000K PIXELS DRIVER-FREE CAMERA
- x/y axis motion to capture images
- Miniature spectrometer & electrochemical sensor
- Advanced Microfluidic chip hosting protein seed compounds

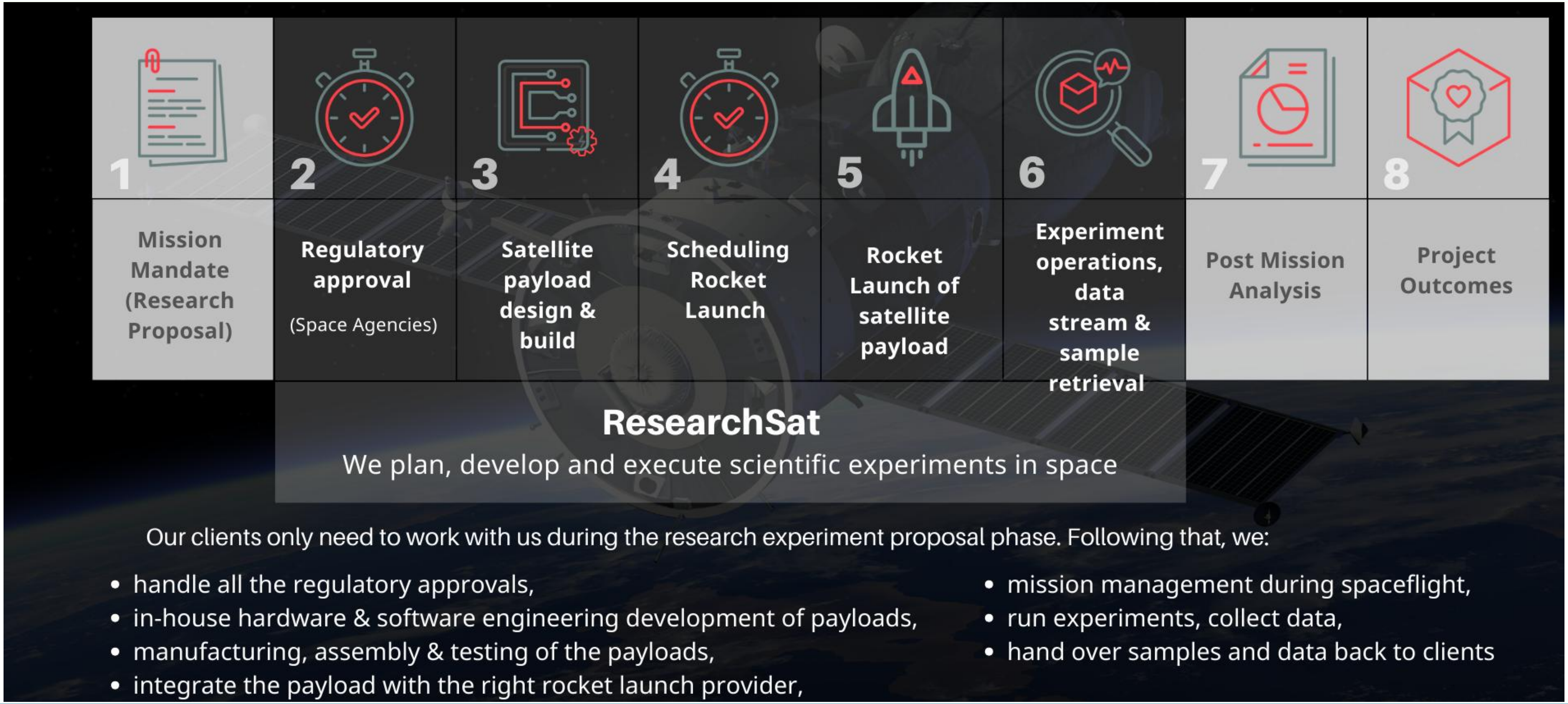
ENVIRONMENTAL CONTROL & MONITORING

- Temperature and humidity regulation
- CO2 & O2 concentration regulation

Fluidic Control & Monitoring

- Micro reservoirs - 50ml capacity,
- Micro-pumps - flow rates from 8µl/min to 10ml/min
- Flow rate & viscosity sensors
- Automated Liquid Handling System

End to End Service



SUBORBITAL MISSION – 1

November 2022 | Esrange Space Center, Sweden

MISSION S1X-3/M15

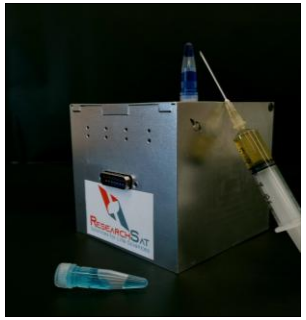
- ResearchSat payload: ADI-Alpha
- Launch provider: Swedish Space Corporation (SSC)
- Launch site: Esrange Space Center, Sweden
- Conducted in November 2022

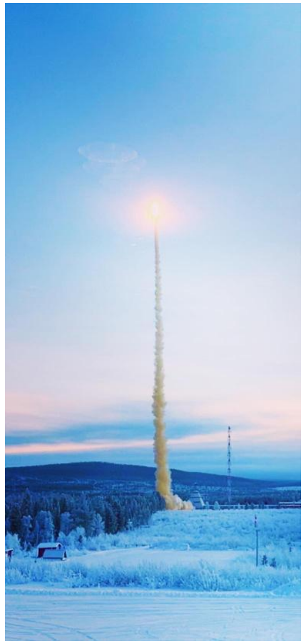
LAUNCH DETAILS

- Flight Duration: Approx. 6 minutes of microgravity
- Flight Altitude: Estimated max altitude is 257 km
- Microgravity level: < 10^(-6)g during microgravity phase

PAYLOAD RECOVERY

- Total rocket payload: 285 kg of scientific instruments including ADI-Alpha
- Recovery Operations: Carried out on same day as flight,
- Payload retrieval by helicopter.





SUBORBITAL MISSION – 1

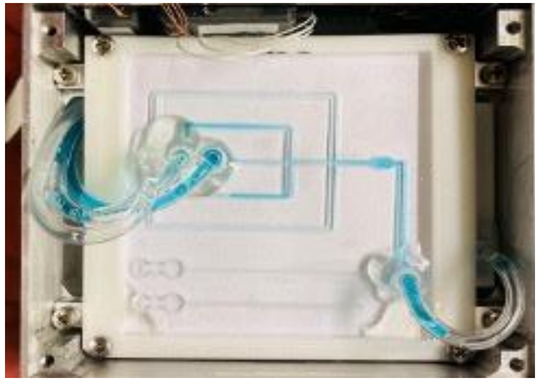
November 2022 | Esrange Space Center, Sweden

SPACE FLUIDIC PLATFORM

- Commissioned by a drug delivery company based in Adelaide
- Generated space double emulsions
- Automated Emulsion Generation
  - A foundation for Space Bioreactor

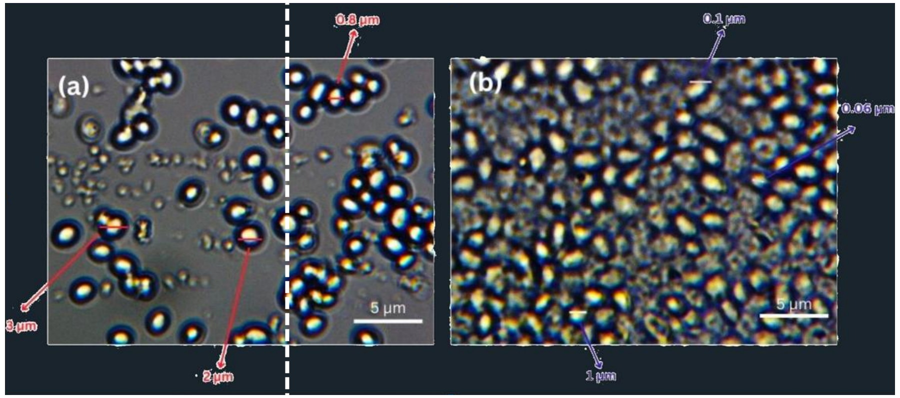
SPACE MICRO-HABITAT

- In-house Research | Academic Collaboration
- Evaluate yeast to develop new antibiotics
- Autonomous Monitoring System
  - A foundation for Space Bioreactor



EMULSION GENERATOR

PUMPS | RESERVIORS



EARTH SAMPLES

SPACE SAMPLES

SUBORBITAL MISSION – 2

February 2024 | Esrange Space Center, Sweden

MISSION DLR/MASER14

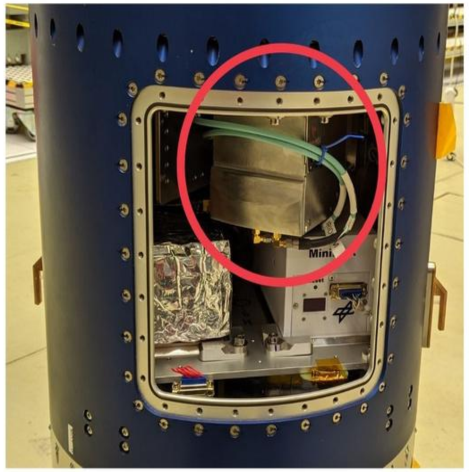
- ResearchSat payload: ADI-ELECTRONIC
- Launch provider: Swedish Space Corporation (SSC)
- Launch site: Esrange Space Center, Sweden
- Conducted in February 2024

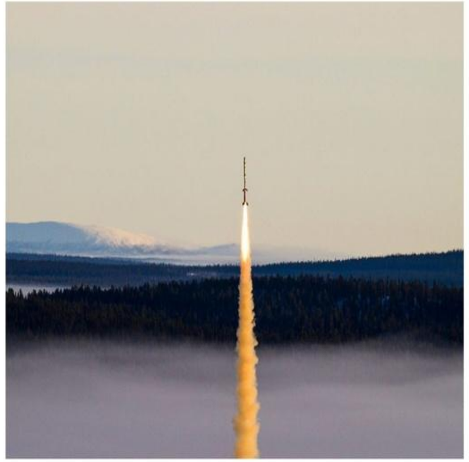
LAUNCH DETAILS

- Flight Duration: Approx 7 minutes of microgravity
- Flight Altitude: Estimated max altitude is 262 km
- Microgravity level: < 10^(-6)g during microgravity phase

PAYLOAD RECOVERY

- Total rocket payload: 400 kg of scientific instruments including ADI-E
- Recovery Operations: Carried out on same day as flight,
- Payload retrieval by helicopter.

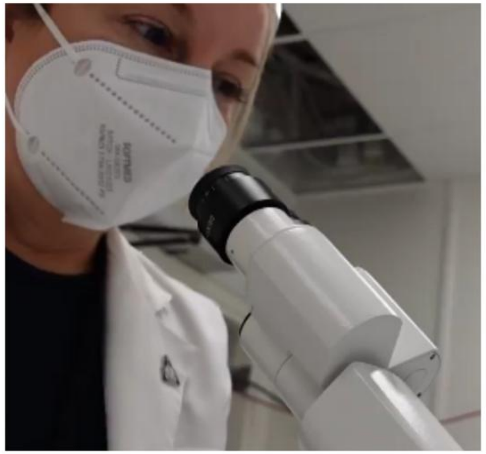


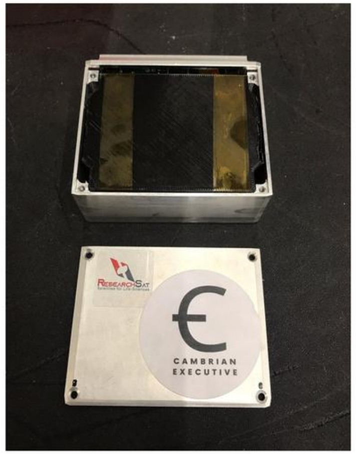


SUBORBITAL MISSION – 2

February 2024 | Esrange Space Center, Sweden

CAMBRIAN EXECUTIVE

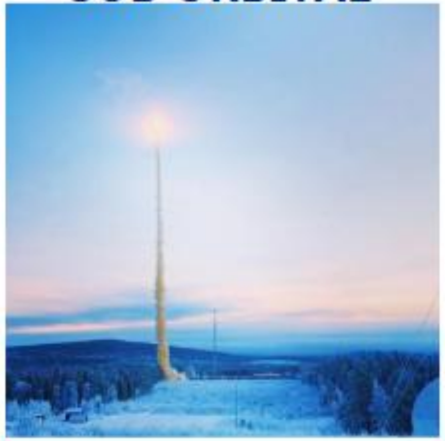




Available Microgravity Platforms

MICROGRAVITY
MISSION TYPES

SUB ORBITAL



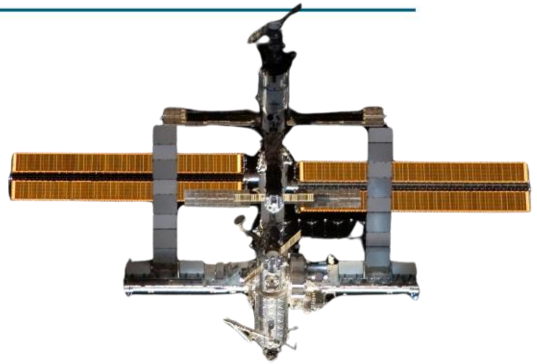
ISS MISSION

LEO MISSION

	SUB ORBITAL	ISS MISSION	LEO MISSION
Altitude range:	250-300 km	400 km	500 km
Microgravity time:	7-10 min	3-6 months	6 - 12 weeks
Microgravity level:	$(10)^{-5}$ g - $(10)^{-6}$ g	$(10)^{-6}$ g	$(10)^{-6}$ g
Payload size & weight:	20x10x10 cm | 1-2 kg	20x10x10 cm | 2-5 kg	30x20x10 cm | 10 kg
Payload Recovery:	Same day of launch	On capsule return	On deorbit

ISS Mission February 2026

ResearchSat is embarking on a mission to the International Space Station (ISS). This mission will involve the development, launch, and operation of a scientific payload designed in collaboration with the client, alongside full engineering and technical support from ResearchSat.



01 **State-of-the-Art Research Opportunity**

- Access to Microgravity
- High Impact Results

02 **Comprehensive Support Package**

- End-to-End Mission Management
- Custom Payload Design
- Live Data and Continuous Monitoring

03 **Return on Investment through Intellectual Property**

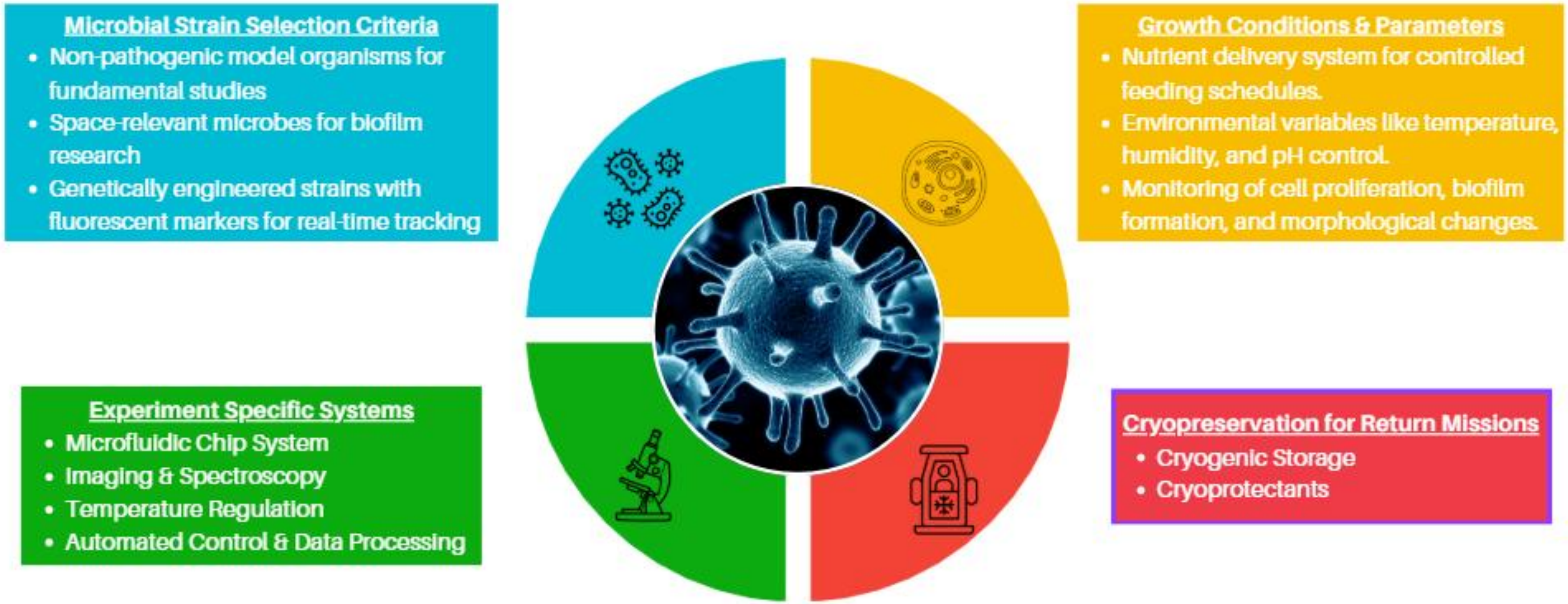
- IP Ownership
- Research Publications & Recognition

04 **Branding and Outreach Benefits**

- **Public Engagement and Branding**
- Recognition in world class scientific communities

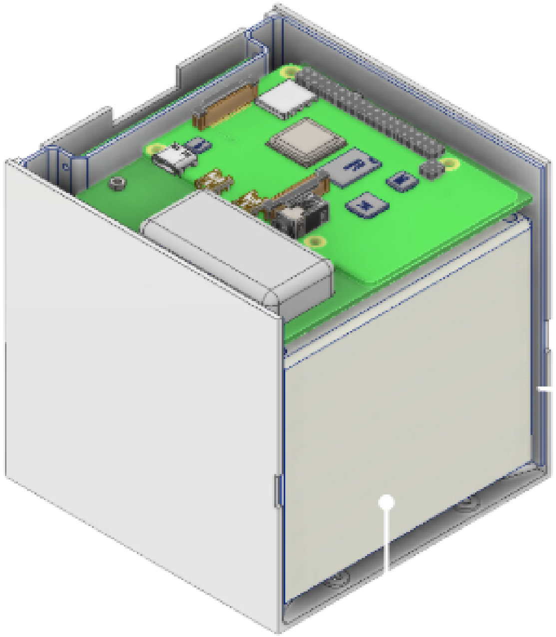
Research Experiment Definition

Project begins with concept exploration of the experiment to be conducted along with necessary objectives, goals and outcomes. Following are some of the critical experiment concept definition requirements



Payload Engineering to Run the Experiment

Based upon the proposed experiment, the SMI chamber within RSat AIDE-LAB platform will be configured for the ISS space flight



SMI Module

01 Microbial Growth Chamber System
Independent growth chambers (~5–15 mL per chamber, equipped for controlled feeding, sample containment and microbial containment.

02 Thermal Control & Environmental Regulation
Temperature regulation unit, humidity control, thermal insulation & radiation shielding

03 Imaging & Monitoring Systems
High-resolution microscope, autofocus & automated image capture, spectrophotometer (UV-Vis or IR), AI-based image processing unit

04 Fluidic & Sample Handling System
Microfluidic chip system, reservoirs for precise nutrient delivery, micro-pumps & valves, fluid exchange system

05 Power & Data Management
Power Supply Management Module for efficient rerouting
Data Transmission:
- Compressed image files (JPEG, PNG)
- Low-bandwidth telemetry for sensor data

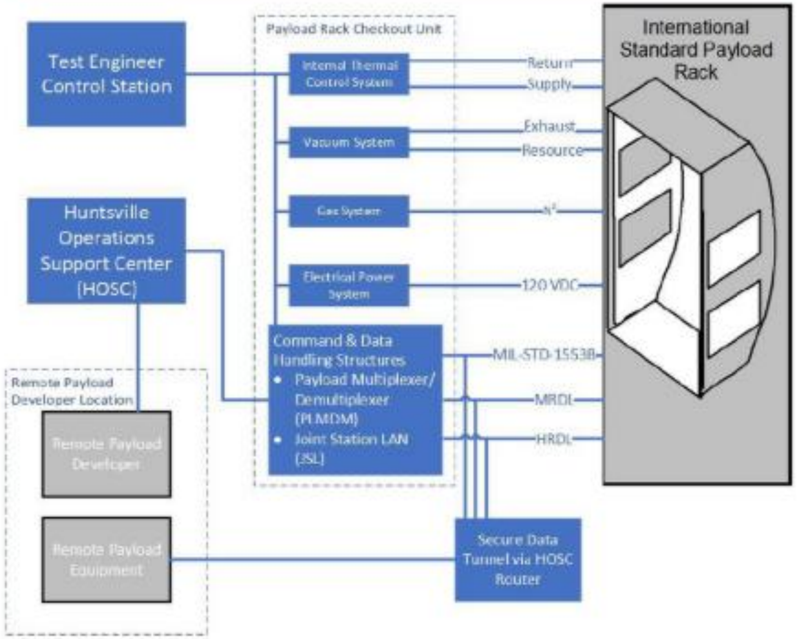
AI-driven onboard processing with sensor fusion of complete module

Parallel development (payload & Experiment ground studies)

Experiment Concept	Biological Validation	Ground Studies	Pre-Launch Finalisation
• Identify microbial strains, culture media and define optimal growth conditions. • Develop the experimental protocol (growth cycles, imaging frequency, etc.). • Begin ground-based microbial growth tests in standard lab conditions.	• Conduct growth tests in simulated microgravity (clinostat/rotating RPM tests). • Test biofilm formation, antibiotic resistance patterns, and colony morphology. • Develop genetic markers (e.g., GFP-tagged bacteria for fluorescence tracking).	• Finalize microbial handling protocols for safe ISS integration. • Test nutrient exchange cycles, waste management, and microbial containment protocols.	• Prepare and package sterile samples for flight. • Run end-to-end dry runs of experiment timing and procedures. • Test procedures and contingencies for in-orbit experiment handling.
0-20%	**20-50%**	**50-75%**	**75-100%**
Payload Concept	**Prototype Development**	**System Integration**	**Flight Hardware Test**
• Define payload architecture (growth chambers, fluidic layout, sensors). • Design micro-pump systems for precise nutrient exchange. • Design microbial containment mechanisms with HEPA filtration.	• Develop early hardware prototypes (growth chambers, imaging sensors). • Integrate fluidic systems with valve control for nutrient flow. • Conduct temperature stability tests for growth chambers.	• Refinement of prototype integrating optimized microfluidics • Stress testing under launch vibration and vacuum conditions • Perform system-level endurance testing (30+ day continuous operation) • Final software integration for real-time imaging and monitoring	• Assembly of final flight-ready hardware • NASA payload certification and safety approvals • Packing, transportation, and launch site integration • Pre-flight functional testing and final system check before launch

Payload Loading onto Rocket

Payload Testing- Marshall Space Flight Center



Extensive tesing is performed for qualification and acceptance testing prior to on-orbit operations by providing access to resources in an ISS-analogous environment

SpaceX Launch Complex - Cape Canaveral, Florida

72-48 hours before launch

Payload put in deep freezers (-95C to 4C)

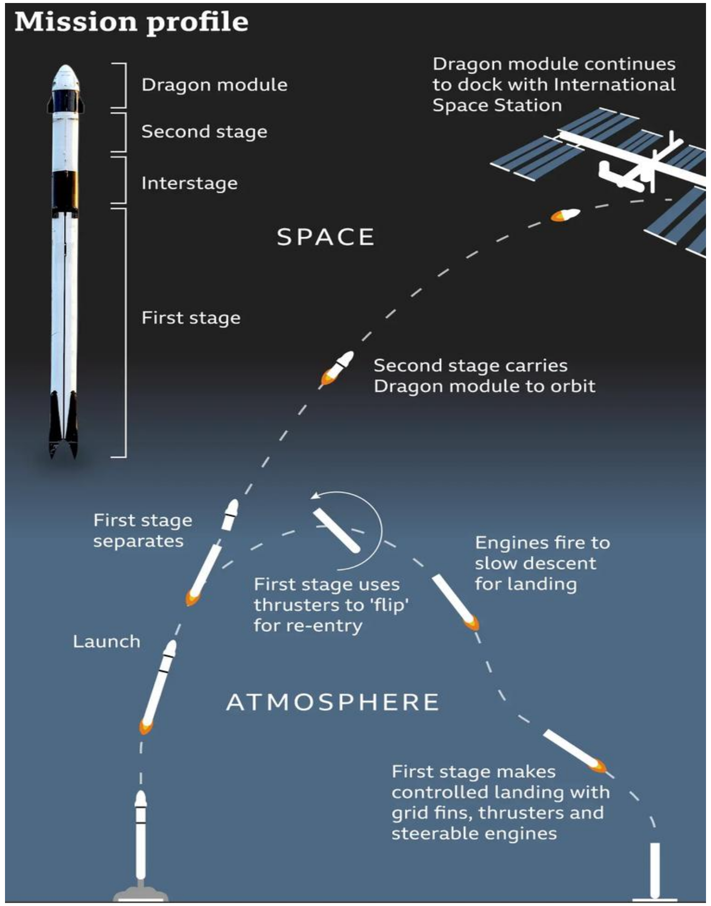
Prepped for launch

30-24 hours before launch

SpaceX & NASA integrating Payload in deep freezers as well as:

- mechanical attachment
- electronic & communication interfacing

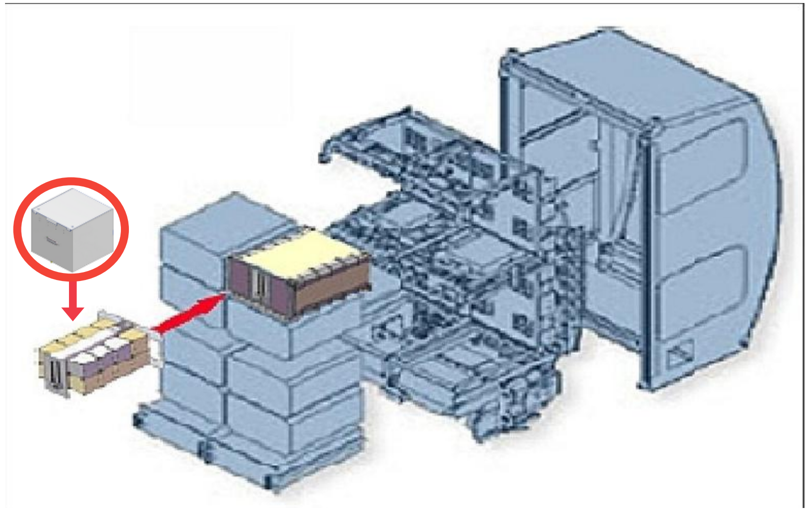
ISS Mission February 2026

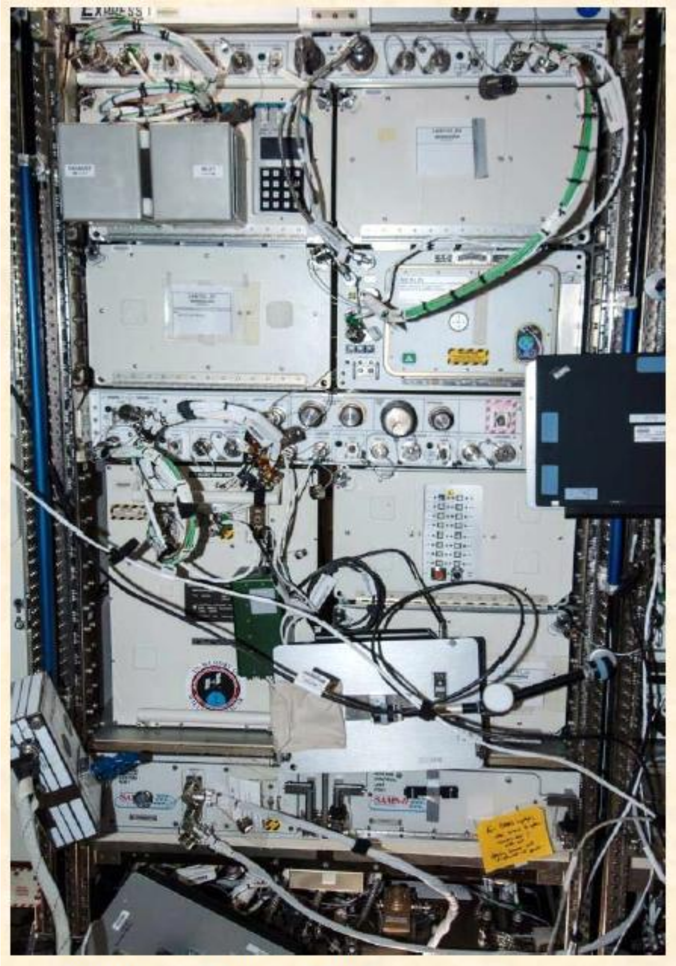


SpaceX launches the Dragon module consisting of payloads, crew and other cargo enroute to the International Space Station (ISS).

On average, the Dragon module of SpaceX carries approximately 6000 kg to the ISS on a single flight

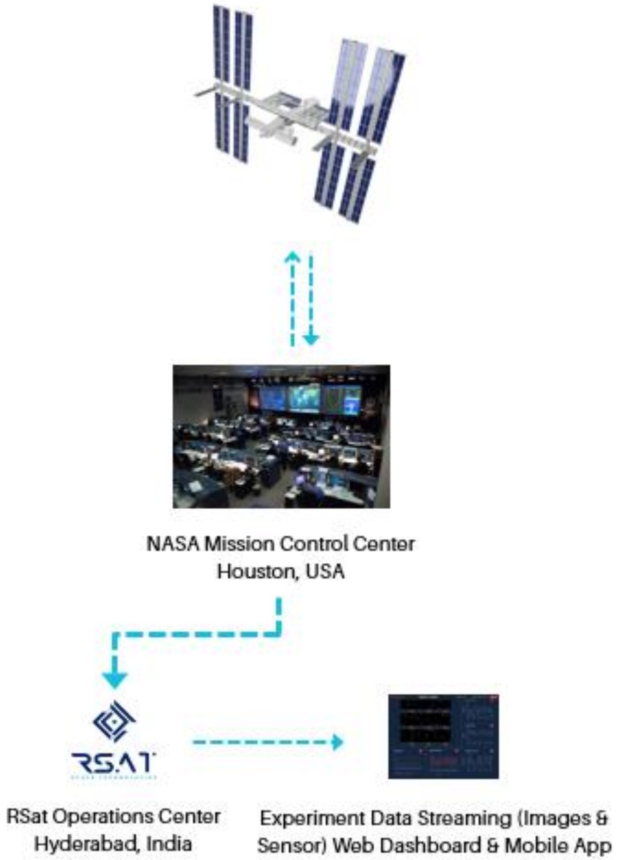
ISS Mission February 2026



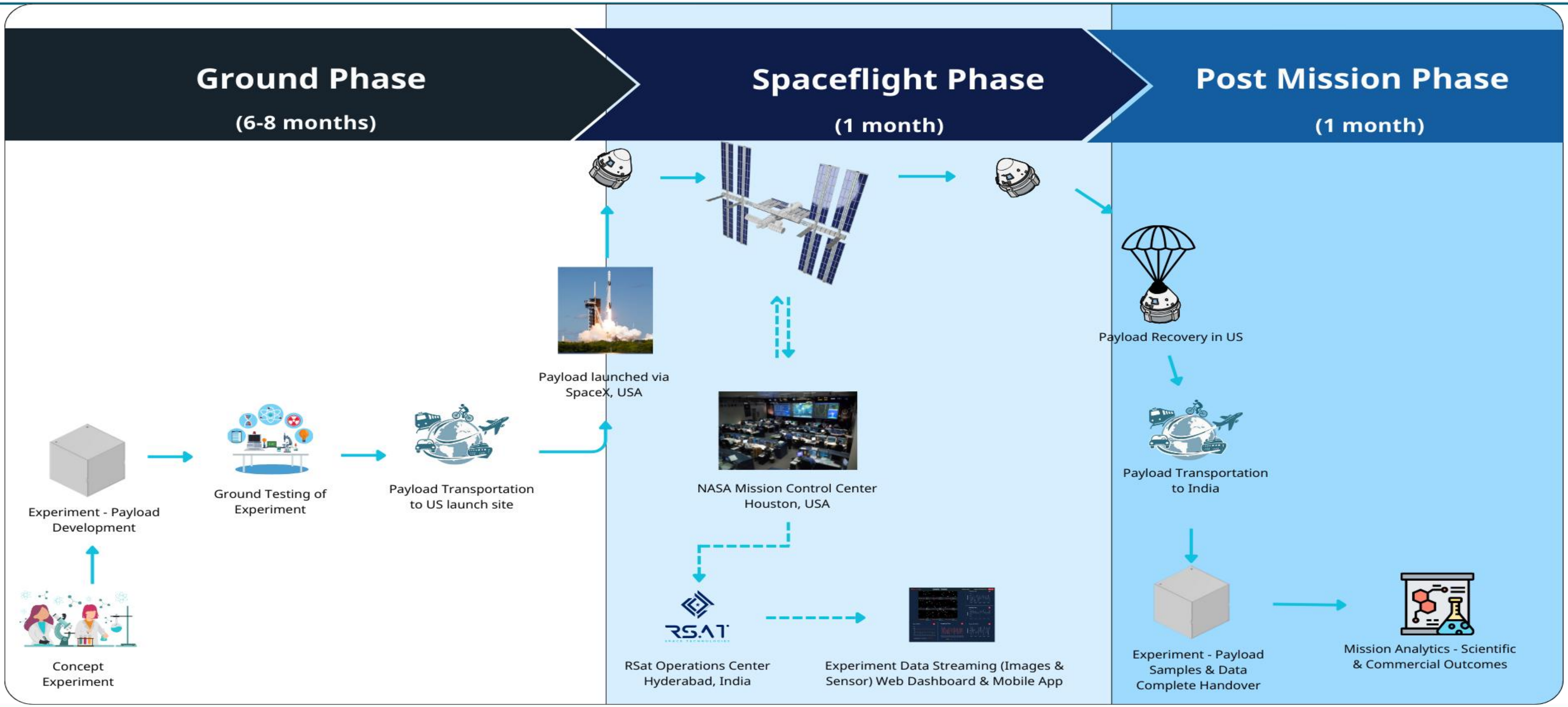


Payload integrated with the ISS Express Rack units as shown in the picture

ISS Mission February 2026



ISS SPACE MISSION WORKFLOW FROM START TO FINISH



Our Upcoming Mission in 2026

UPCOMING **MISSIONS**

ISS MISSION

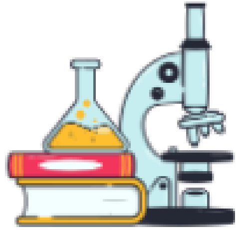
ALTITUDE RANGE:	400 km
MICROGRAVITY TIME:	1 month
PAYLOAD SIZE:	10x10x10 cm
WEIGHT:	1-2 kg
FLIGHT SCHEDULE:	FEB 2026

USA

- **Active Experimentation**
- **Passive Experimentation**
- **Cell Bank Experiment**
- **In Space Manufacturing**

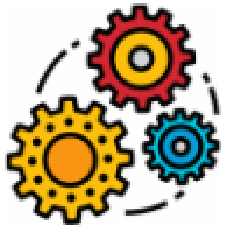
A range of research experiment options, all-inclusive of end-to-end services

Unlocking Opportunities for Science & Business



Scientific

Precision-driven experiments and insights unattainable on Earth



Technical

Advanced instrumentation and AI-driven analytics

Pharmaceutical

Better drug efficacy, new formulations, and faster R&D cycles

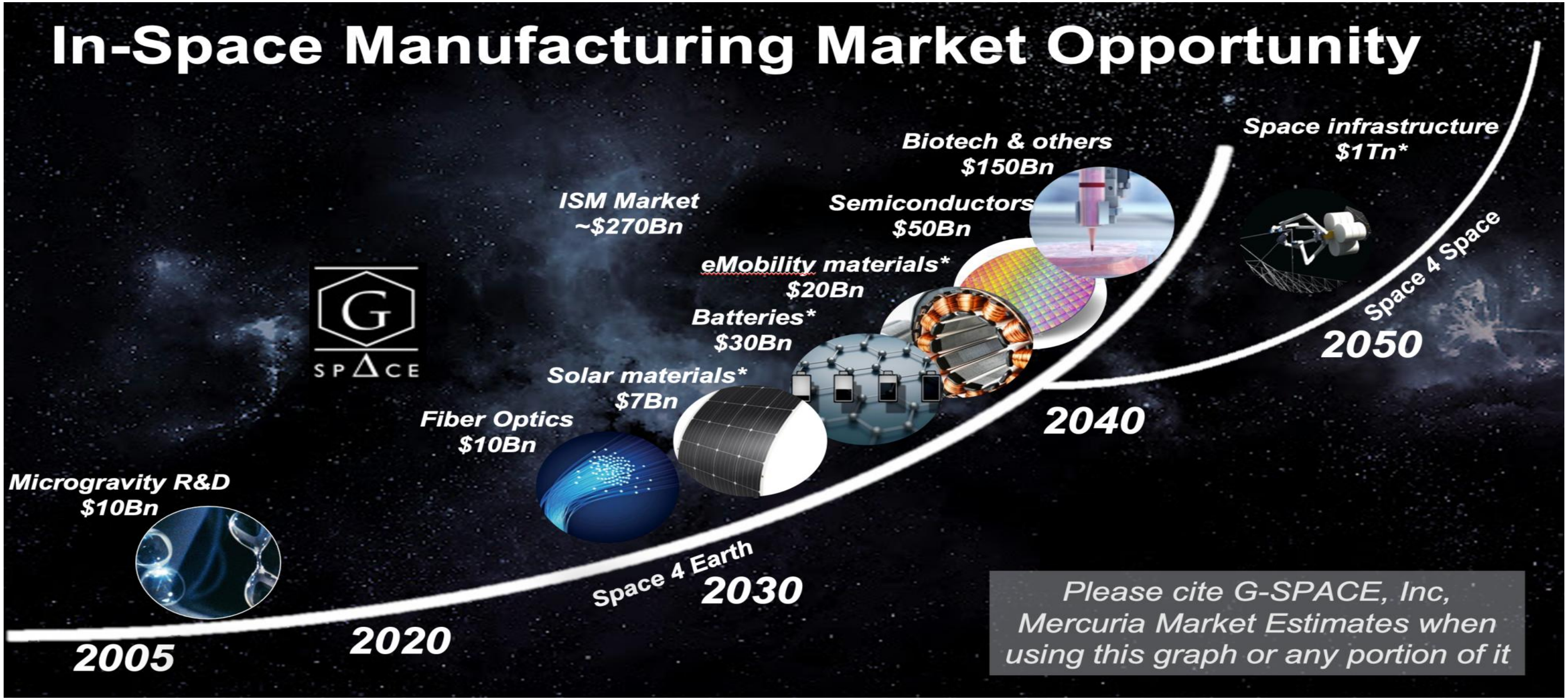
Commercial

Competitive advantage and IP generation in a frontier market

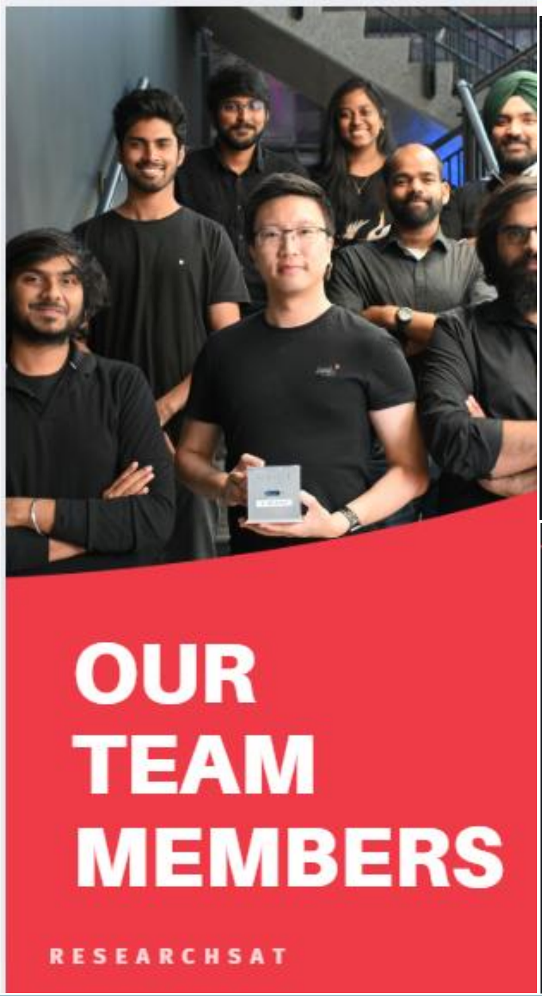
Marketing

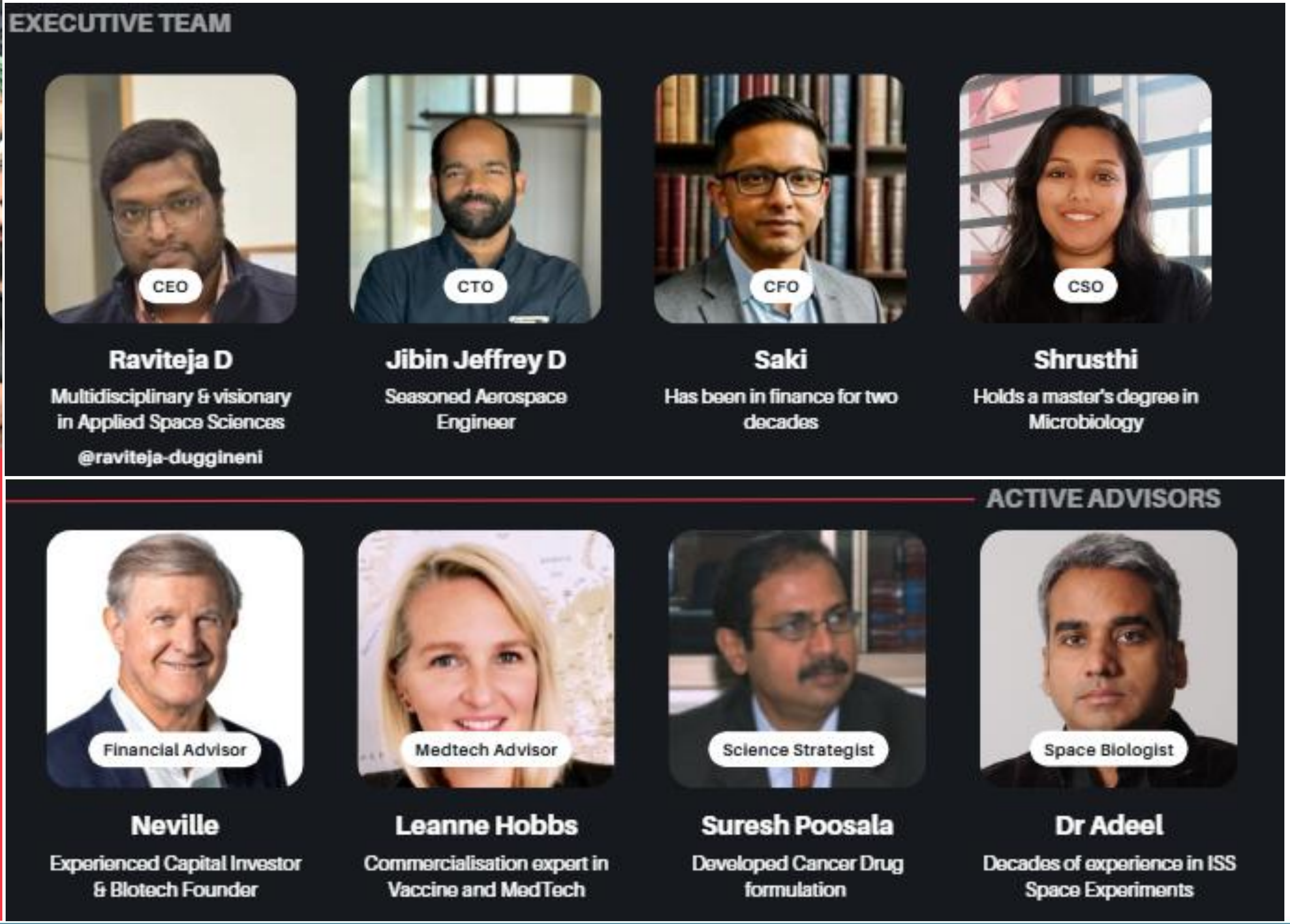
Unique branding and storytelling as pioneers in space research

What is emerging now



ResearchSat Team





RSat Space Technologies

Incorporated in Hyderabad

(Active mid Sep'24)

Jibin Jeffrey Dhanaraj
CEO

Rahul Shetty
CBDO

Shrushti Patil
CSO

Earnest Sundar Daniel
COO

1. **CUSTOM SATELLITES**
   LIFE SCIENCE PAYLOADS
2. **TURNKEY LOGISTICS**
   POOL OF LAUNCHERS
3. **COLLABORATION & NETWORKING**
   RESEARCH JOURNALS

- **Biotechnology & Pharmaceuticals**
- **Universities**
- **ISRO**

Thank You