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Cedars Sinai
Regenerative Medicine Institute

Pioneering Medical Solutions in Microgravity: iPSCs in Lower Earth Orbit

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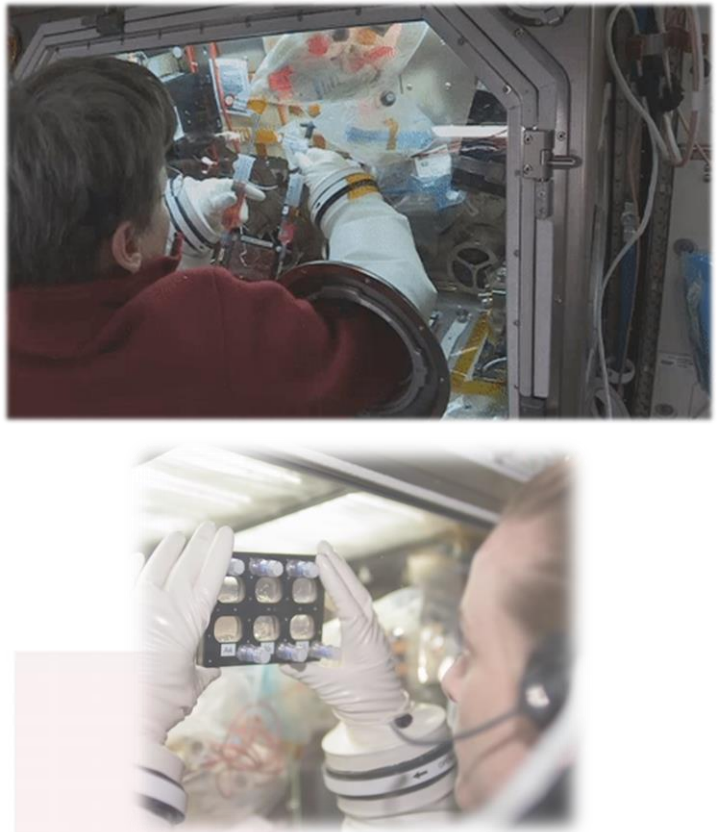
AIRBUS
Technical Session Sponsor

In-Space Manufacturing in Low Earth Orbit

- The ISS has served as Earth's sole orbiting laboratory for decades providing unique opportunities to expand our knowledge on fundamental science of our world.
- Multidisciplinary experiments in engineering, biology, and material sciences can benefit from research conducted at the ISS
- Uniform removal of a strong mechanical load (gravity) achieved on the ISS, unlike microgravity simulators on Earth, opens the door to unique findings and advancements in cancer treatment, retinal science, new drug development, and cell therapies.

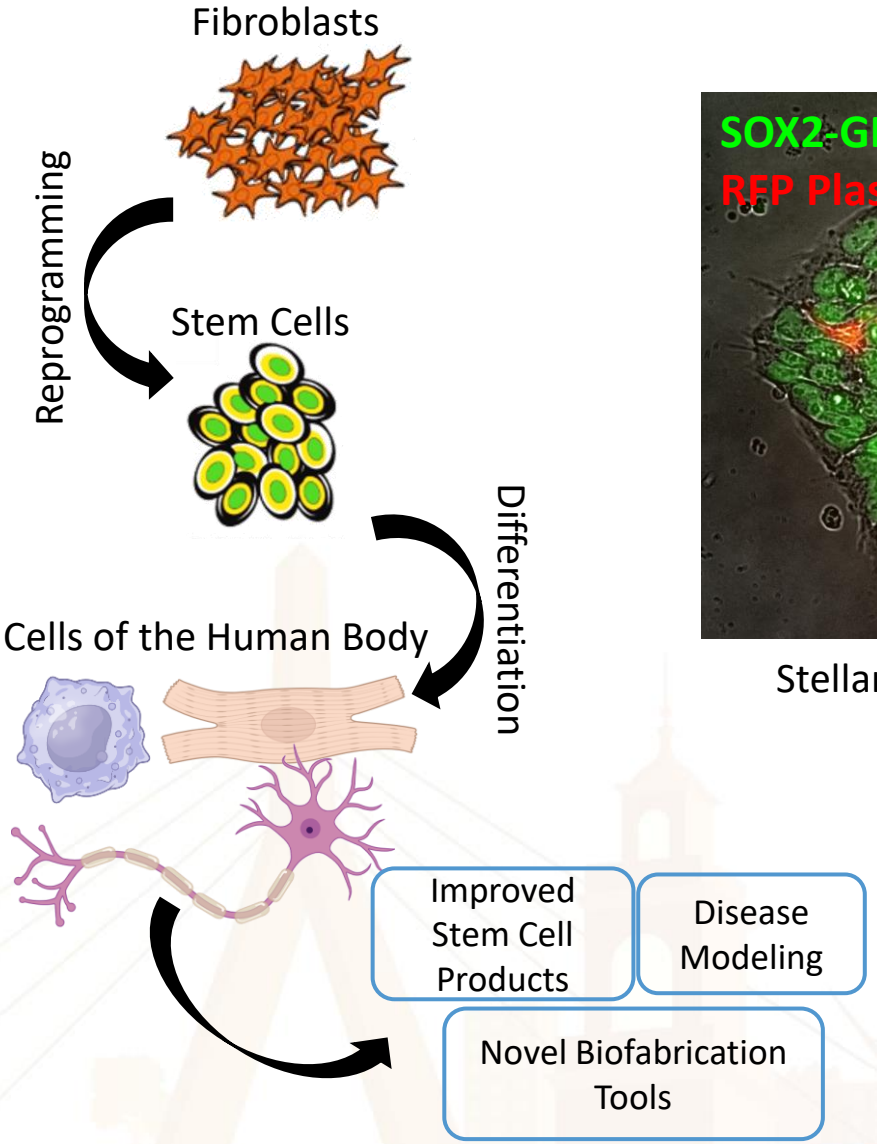
Space Automated Bioproduct Laboratory (SABL) aboard ISS

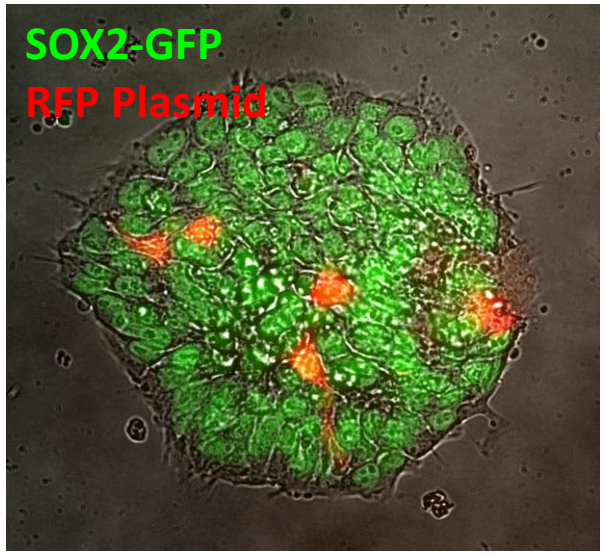


Astronauts Peggy Whitson (top), and Kate Rubins (bottom) conduct stem cell research on ISS (Source: NASA)

Wnorowski and **Sharma** et al, 2019. *Stem Cell Reports*.

Induced Pluripotent Stem Cells in Lower Earth Orbit





Stellar Stem Cells Project

- Production, expansion, and differentiation of iPSCs on Earth are expensive and time-consuming, limiting global access to cell and gene therapy solutions.
- Induced pluripotent stem cell (iPSC) production on Earth is less than 13% efficient.
- Previous studies have shown that cellular mechanosensing, proliferation, and differentiation are positively altered in microgravity in cells such as endothelial cells and hematopoietic stem cells.
- The spontaneous formation of spheroids in orbit, instead of a 2D layer, benefits cellular crosstalk and potentially improves overall cell health.

Cedars-Sinai Missions in Space Bioscience

Arun Sharma PhD

Clive Svendsen PhD

Dhruv Sareen PhD

Madelyn Arzt

July 15th 2022 — **Space-X 25**

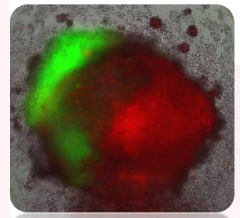
May 21st 2023 — **Axiom Precursor Mission (Ax-2)**

November 9th 2023 — **Space-X 29**

January 30th 2024 — **Cygnus (NG-20)**

August 3rd 2024 — **Axiom Mission 1 (NG-21)**

February 2025 — **Axiom Mission 2**



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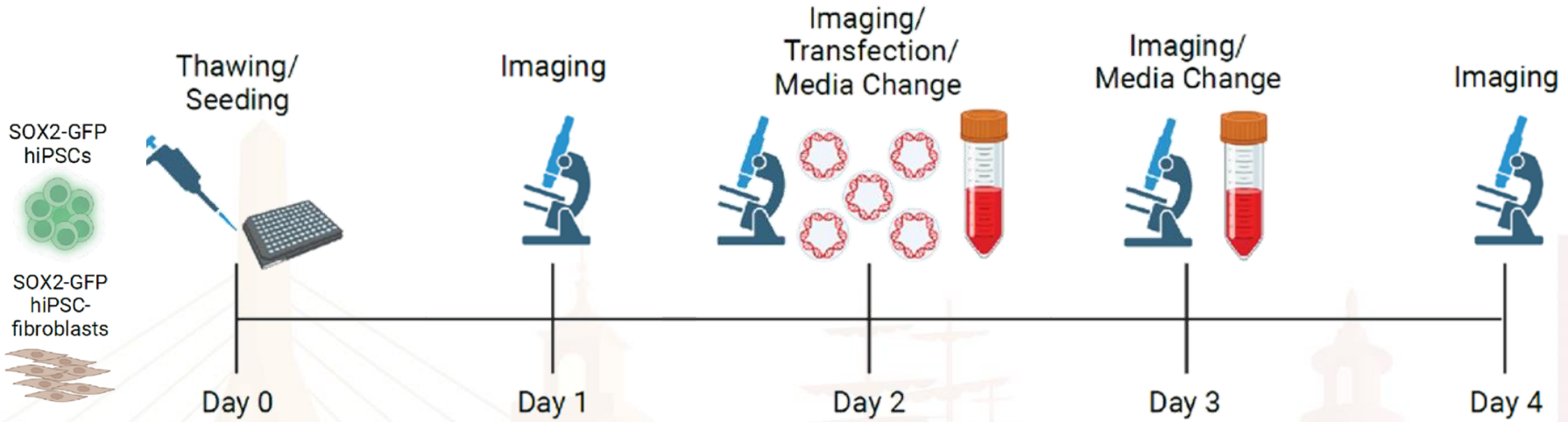
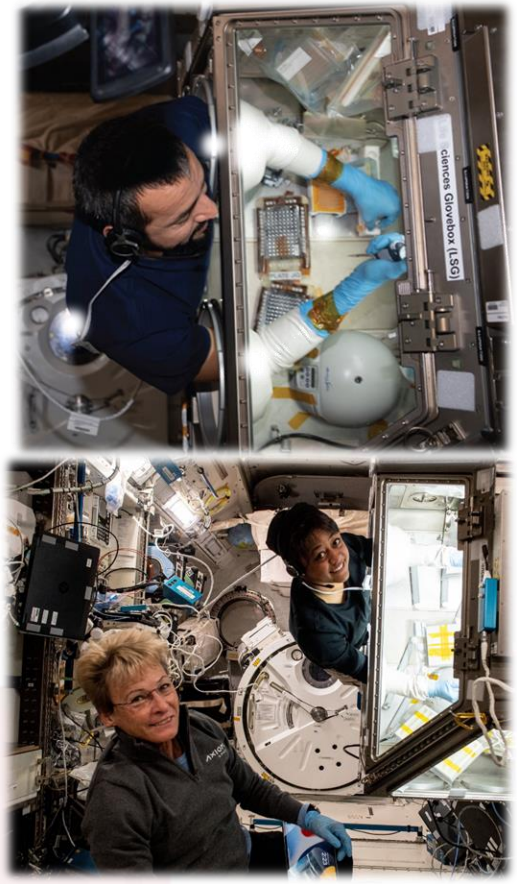
2024 Technical Sessions

ISSRDC

Design and Implementation of an Experiment in LEO: A Case Study

Stellar Stem Cells Precursor Mission (AX-2):
Culture and transfection of iPSCs and iPSC-fibroblasts during a private spaceflight mission using commercial well plates





Astronauts Sultan Neyadi, Peggy Whitson, and Rayyanah Barnawi conducting Ax-2 operations.

Stellar Stem Cells (Ax-2): A Case Study (continued)

Phase I: Establishing in-Space Conduct of the Protocol

In-SPA Grant Awarded

Fall 2021

- Material storage condition test
- Testing the addition of required containment levels
- Optimizing cell count and seeding methodology for LEO
- Imaging device compatibility with selected culture devices

Experiment definition complete, and submitted to NASA for safety assessment

Summer 2022

Phase II: Experiment Verification Test (EVT)

- Flight manifest finalization, and scheduling of the EVT — **November 2022**
- Completing the EVT run with flight kits — **February 2023**
- Final changes to the manifest submitted — **March 2023**

Preparations for launch.

Stellar Stem Cells (Ax-2): A Case Study (continued)

Phase III: Launch Week

Point of contact allocated at the space center

April 2023

- Trainings:
  1. Safety at the space center
  2. Imaging session training

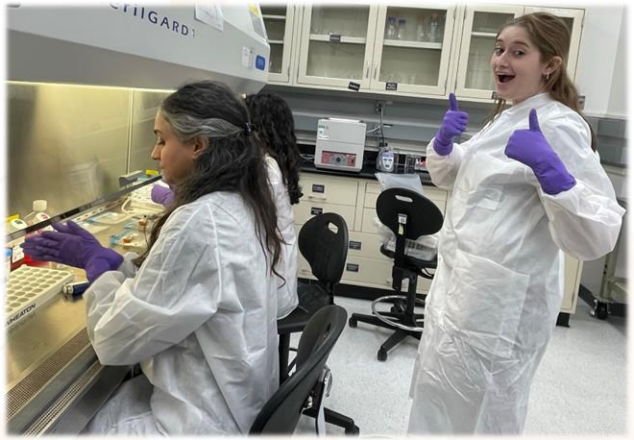
  April 2023
- Shipping experiment material to the space center

  April 2023
- Pre-launch preparations at the space center (if required by the protocol)

  May 2023
- Handover to NASA

  May 2023

Liftoff!



Our team in collaboration with our implementation partners, BioServe Space Technologies, at the Kennedy Space Center for Ax-2 launch preparations.

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Stellar Stem Cells: Ax-2 Launch from Kennedy Space Center, FL

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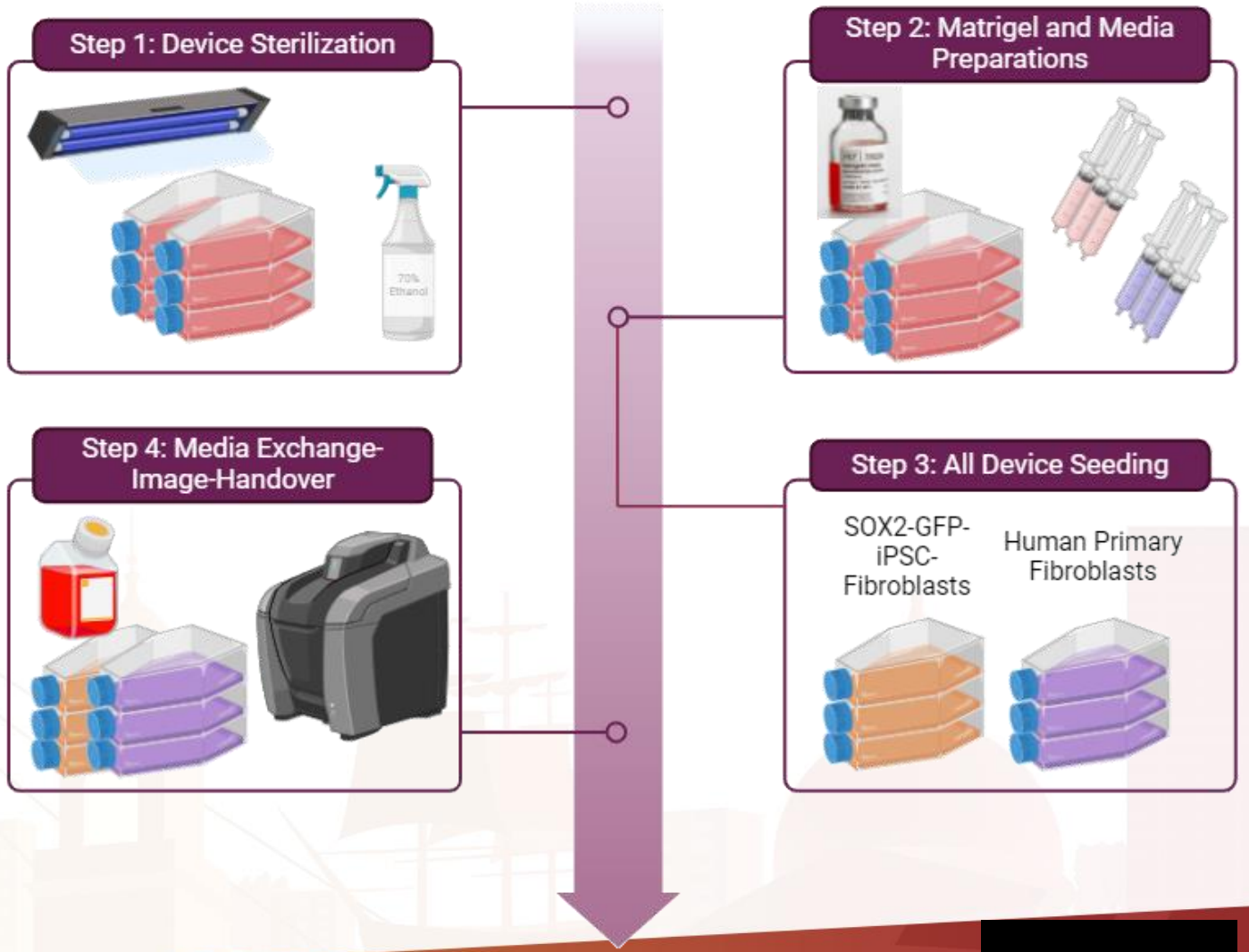
Stellar Stem Cells Mission 1 Workflow

(August 3rd, 2024)



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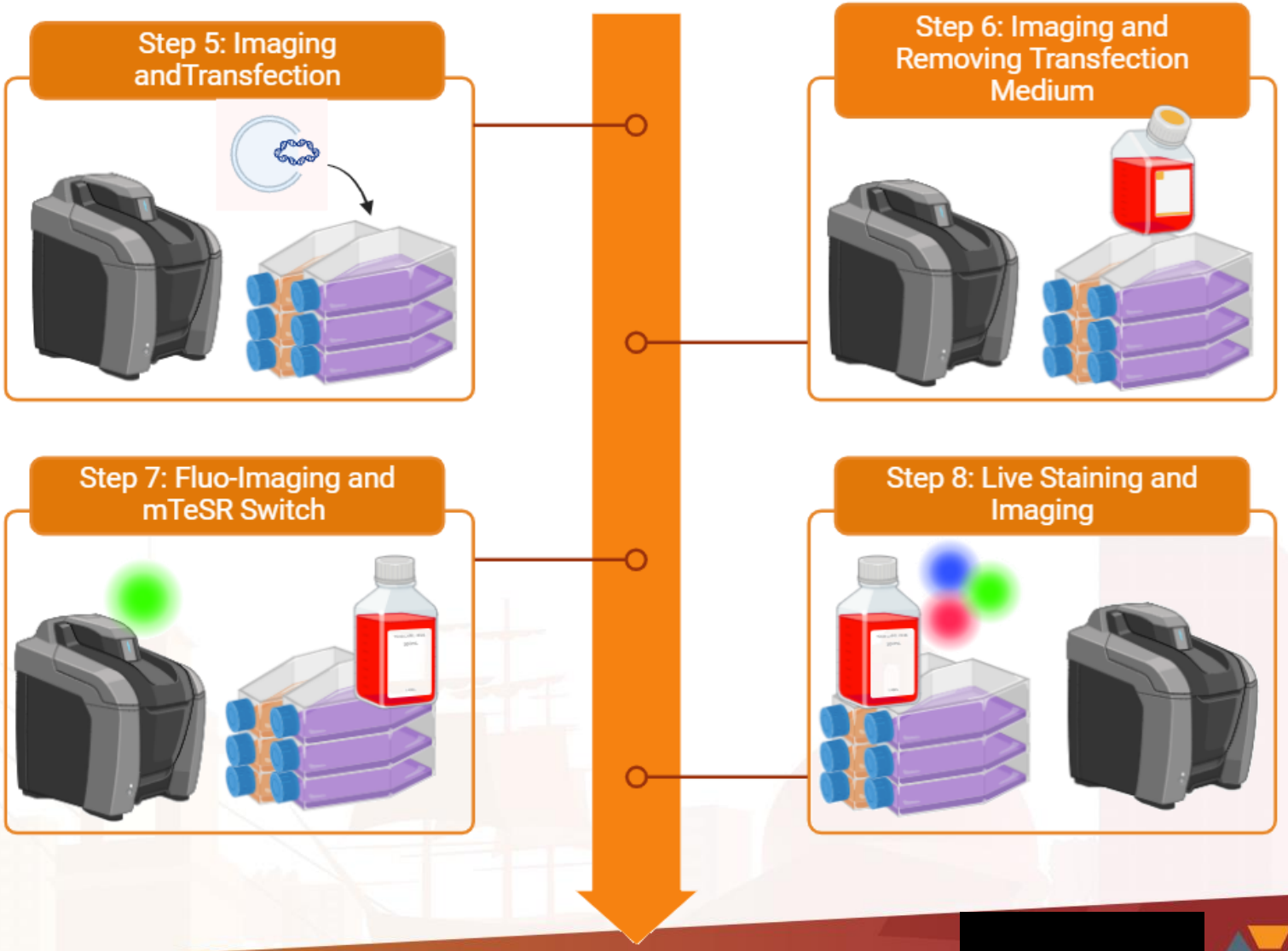
Stellar Stem Cells Mission 1 Workflow

(August 3rd, 2024)



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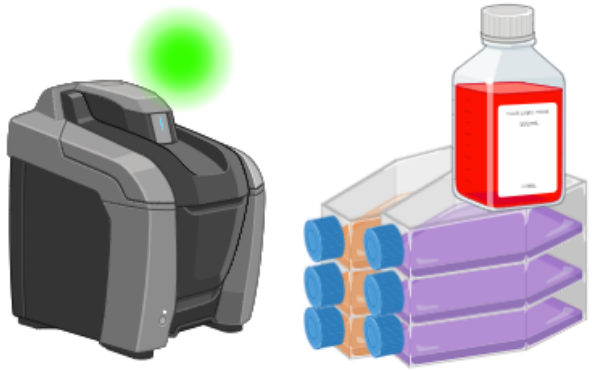
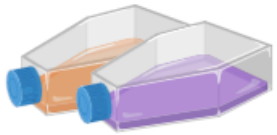
Stellar Stem Cells Mission 1 Workflow

(August 3rd, 2024)

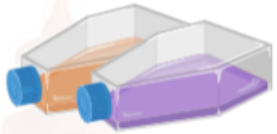
Step 9: Imaging and Medium Change



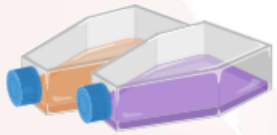
Step 10: Return to Earth Preparations



PFA Fix



Cryopreserve



RNA Extraction

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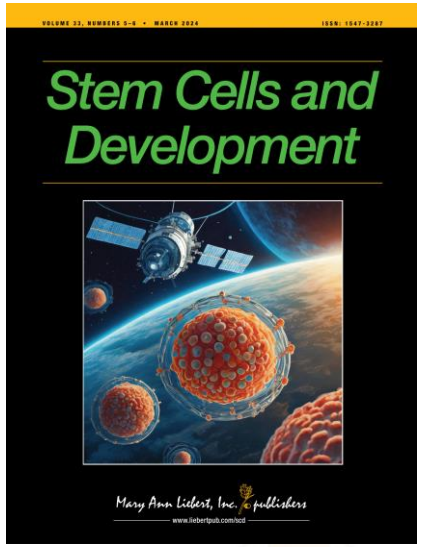
References



npj | microgravity

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Sharma Lab Members

THANK YOU!

Clive Svendsen
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Rayyanah Barnawi
Ali Al Qarni
Peggy A Whitson
John Shoffner

BioServe Space Technologies

Axiom Space

Airbus
Technical Session Sponsor

NASA

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