Biomanufacturing Performance and Transcriptomic Response of Engineered *Escherichia coli* in Simulated and Spaceflight Variable Gravity

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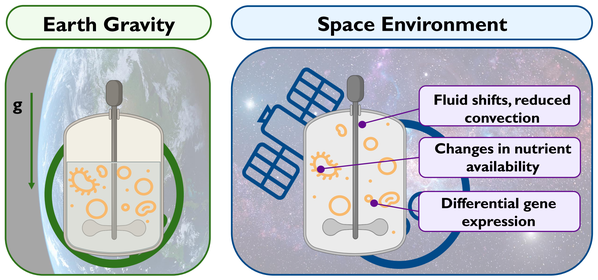
Introduction

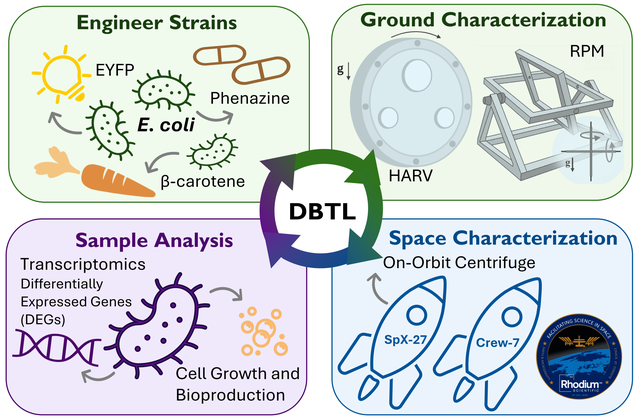
Current Human Presence in Space
- Requires access to medicine, nutrients, and fuel
- Is expensive and time-consuming to resupply

Future Human Presence in Space
- Includes Moon and Mars mission support
- Calls for *In Situ* Resource Utilization (ISRU)

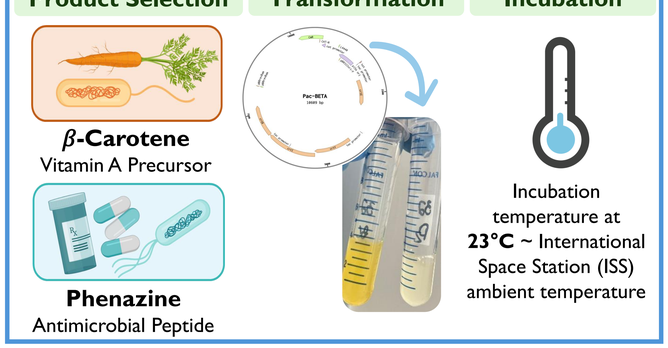
Biomanufacturing for Human Presence in Space
- Reduces cost and accessibility concerns



Workflow

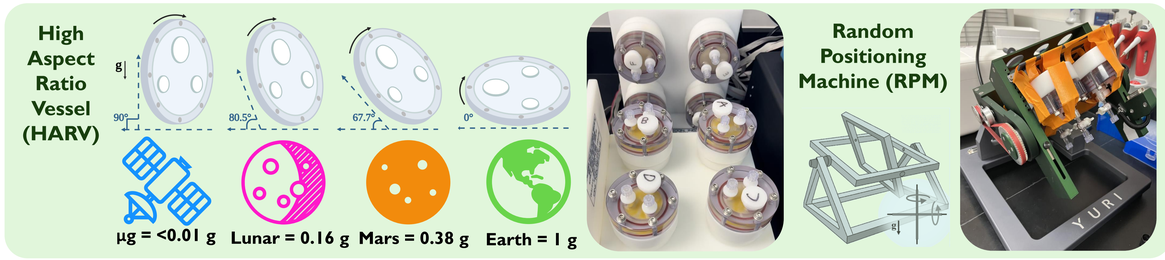


Methods

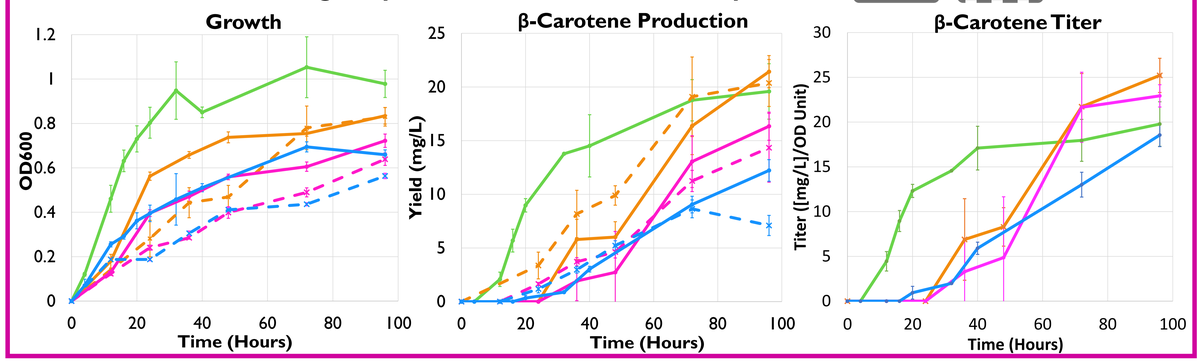


Lab-Based Characterizations (Simulated Variable Gravity)

Methods for Generating Low Shear Modeled Microgravity (LSMMG):



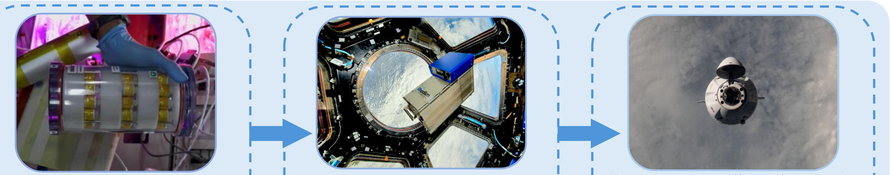
Low Shear Modeled Microgravity and Simulated Variable Gravity Results: HARV RPM



Space Characterizations (Spaceflight Variable Gravity)

Method for Characterizing Spaceflight Variable Gravity:

SpaceX CRS-27

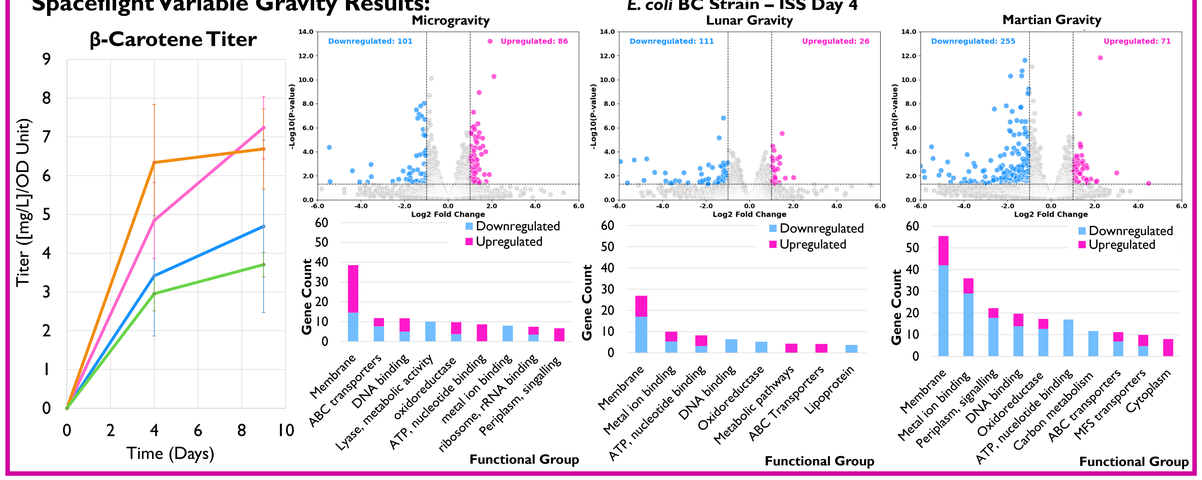


Send samples (frozen) to ISS
***E. coli* wild type (WT) and β-Carotene producing (BC)**

On station: thaw and incubate at micro-, Lunar, or Martian gravity
Freeze samples at 4 and 9 days

Return samples (frozen) to Earth
Quantify growth and production, and gene expression via transcriptomics

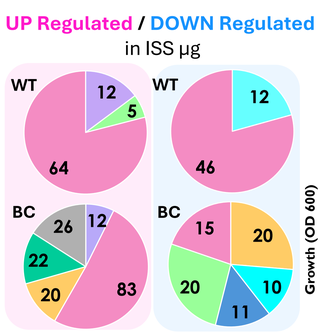
Spaceflight Variable Gravity Results:



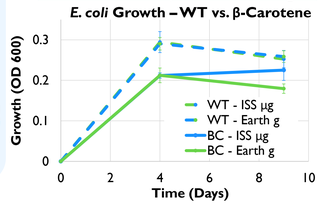
Towards Improving Performance

Spaceflight DEGs of WT vs. Engineered Strain:

UP Regulated / **DOWN Regulated** in ISS μg

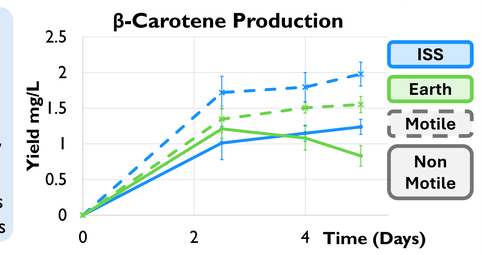


Membrane, transmembrane
Cytoplasm
Signal, periplasm
ATP-binding, transporters
Lyase, metabolic pathways
DNA binding, transcription
Kinase, transferase
Oxidoreductase, metal ion binding



Additional Cell Factors on Biomanufacturing:

SpaceX Crew-7
- Motility
- Antibiotic Stress
- Repeated Strains



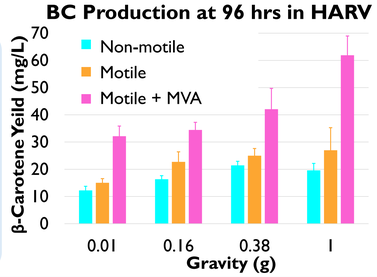
Conclusions and Ongoing Work

LSMMG:
- HARV and RPM models show that growth and bioproduction decrease with gravity level: Earth, Mars, Moon, and Microgravity

Spaceflight:
- Confirmed that HARV and RPM capture improved bioproduction in Mars and Moon gravity compared to microgravity
- Motility increases biomanufacturing performance in microgravity

Current work:

SpaceX CRS-31
- Improved Strains
- Variable Gravity



Acknowledgements and Contact

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