



National Aeronautics and
Space Administration

NASA BPS Space Crops Program and Goal Update

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Executive

BPS Advisory Committee Meeting
November 22, 2024

BPS

Biological & Physical Sciences



Agenda

- Science Highlights
 - Awards and Recognition 
 - Completed ISS Experiments 
 - Major grants 
- Engagement and Outreach
- Publications Overview
- Space Crops Roadmap Update



Recognition: Outstanding research accomplishments, mentorship, service



Dr. Anjali Iyer-Pascuzzi
Recognized by the American Society of Plant Biologists (ASPB) as one of 25 inspiring Women in Plant Biology.



Dr. Aubrie O'Rourke
2024 Early Career Achievement Medal. Significant performance within 10 years of service to NASA mission.



Drs. Sarah Wyatt and Raymond Wheeler
Elected as 2023 ASGSR Fellows for distinguished scientific and social contributions to the advancement of gravitational and space research through research, education, mentoring, outreach, and professional and public service.

BPS PI Conducts Own Suborbital Experiment on Blue Origin New Shepard-26

- Dr. Rob Ferl (University of Florida) is the first NASA-funded researcher to conduct his own experiment in space.
- The experiment launched from and returned to Blue Origin's West Texas Suborbital Launch Site on 08/29/24.
- One of the first experiments to examine genes that change expression as biology (plants) transition to and from microgravity.
- Pre and post launch activities were covered by more than 20 media outlets, including ABC, NBC, and CBS.



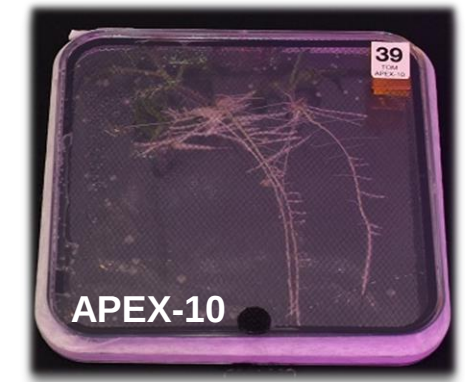
Dr. Rob Ferl exiting the NS-26 spacecraft after it returned to Earth.



Dr. Rob Ferl preparing to activate KFTs on NS-26.

Three ISS Plant and Microbial Experiments Completed

- **Plant Habitat-06 (PH-06) tomato plant immune response**
 - Launched on SpX-29 (11/09/23); returned on Ax-3 (02/07/24)
 - PI: Dr. Anjali Iyer-Pascuzzi, Purdue University
- **Advanced Plant Experiment-10 (APEX-10) tomato-microbe experiment**
 - Launched on NG-20 (01/30/24); returned on Crew-7 (03/11/24)
 - PI: Dr. Simon Gilroy, Univ. of Wisconsin-Madison
- **Biological Research in Canisters-25 (BRIC-25) *Staphylococcus aureus* bacterial experiment**
 - Launched on NG-20 (01/30/24); returned on SpX-30 (04/28/24)
 - PI: Dr. Kelly Rice, Univ. of Florida



Lunar Effects on Agricultural Flora (LEAF)

PI: Christine Escobar [Space Lab Technologies, LLC]

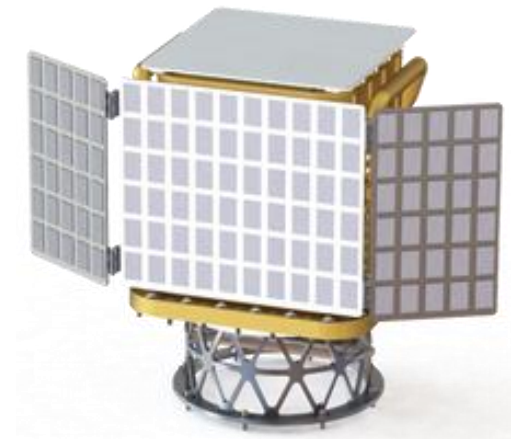
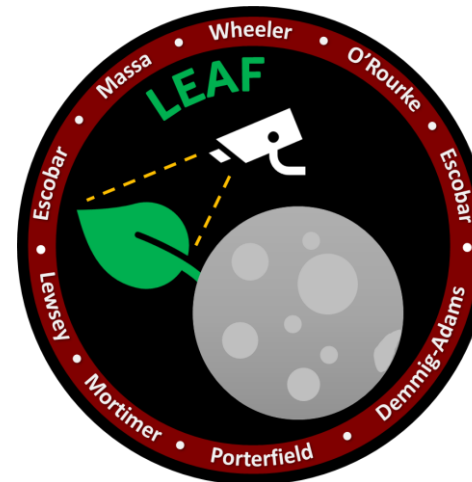
Managed by PMPO, MSFC

Co-sponsored by NASA SMD Exploration Science Strategy Integration Office (ESSIO) and BPS

- Space Lab Technologies LLC-led research study with Deputy Principal Investigator and Co-Investigators from Kennedy Space Center, Purdue Univ., Univ. of Colorado-Boulder, and USDA [collaborator]
- Selected through the Artemis 3 Deployed Instruments solicitation as a candidate for lunar surface deployment
- Will enable the first detailed investigation on the effects of the lunar surface environment on plant physiological processes
- Aims to understand how plants grow in partial gravity and in lunar surface radiation environment; provide data for future crop growth methods and technologies sustaining lunar habitation and beyond



LEAF Specimens: *Arabidopsis thaliana*, *Wolffia australiana* (duckweed), and *Brassica rapa*



LEAF payload concept
(Credit Space Lab Technologies)

International Space Life Sciences Working Group (ISLSWG)

- ‘Plants in Space’ workshop held at 28th European Low Gravity Research Association (ELGRA) biennial meeting in Liverpool, UK (Sept. 3-6, 2024)
- Organized by NASA and the German and Italian Space agencies (DLR, ASI)
- 200 delegates attended the ELGRA meeting; 50 international space agency delegates presented at the ISLSWG workshop
- Viewpoint article capturing the main points raised at the workshop will be submitted to the *New Phytologist* journal (March. 2025)



Dr. Lynn Harrison, NASA Space Biology Program Scientist, participating in a cross-agency panel on the future of microgravity research



Space Crops Publications Overview (Oct. 2023-Sept. 2024)

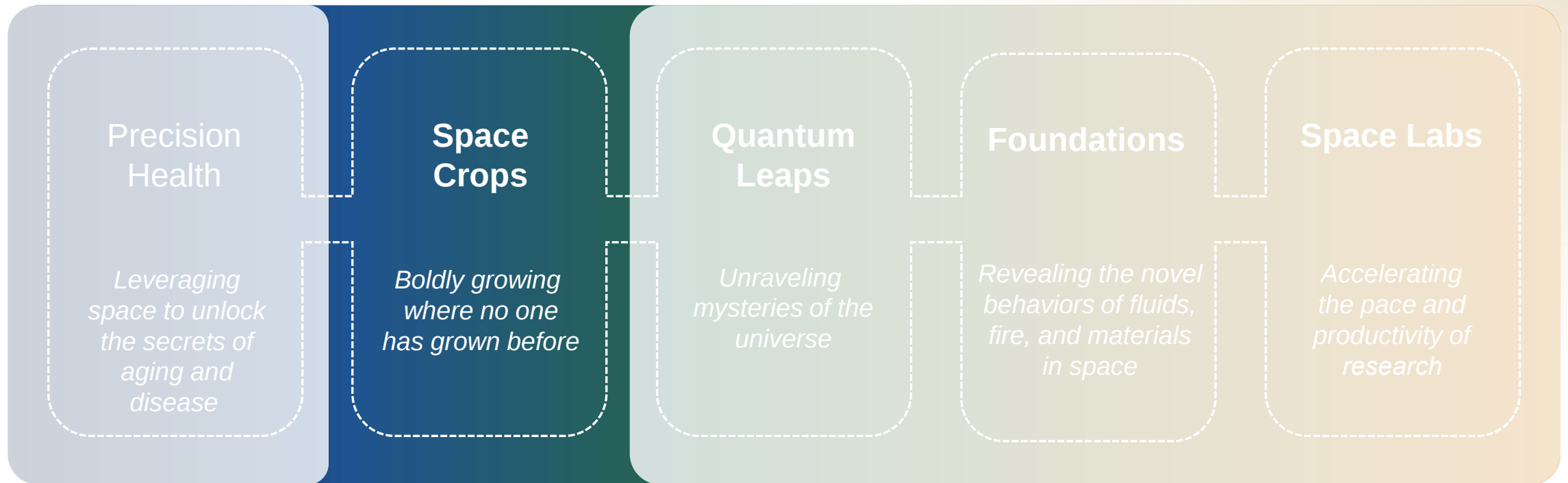
32 Peer reviewed papers: 10 Spaceflight and 22 Ground-based; 16 Basic Plant Biology, 8 Space Crop Production, 3 Microbiology, 2 Animal Biology, 2 Cell Biology, and 1 Perspective

Major Findings

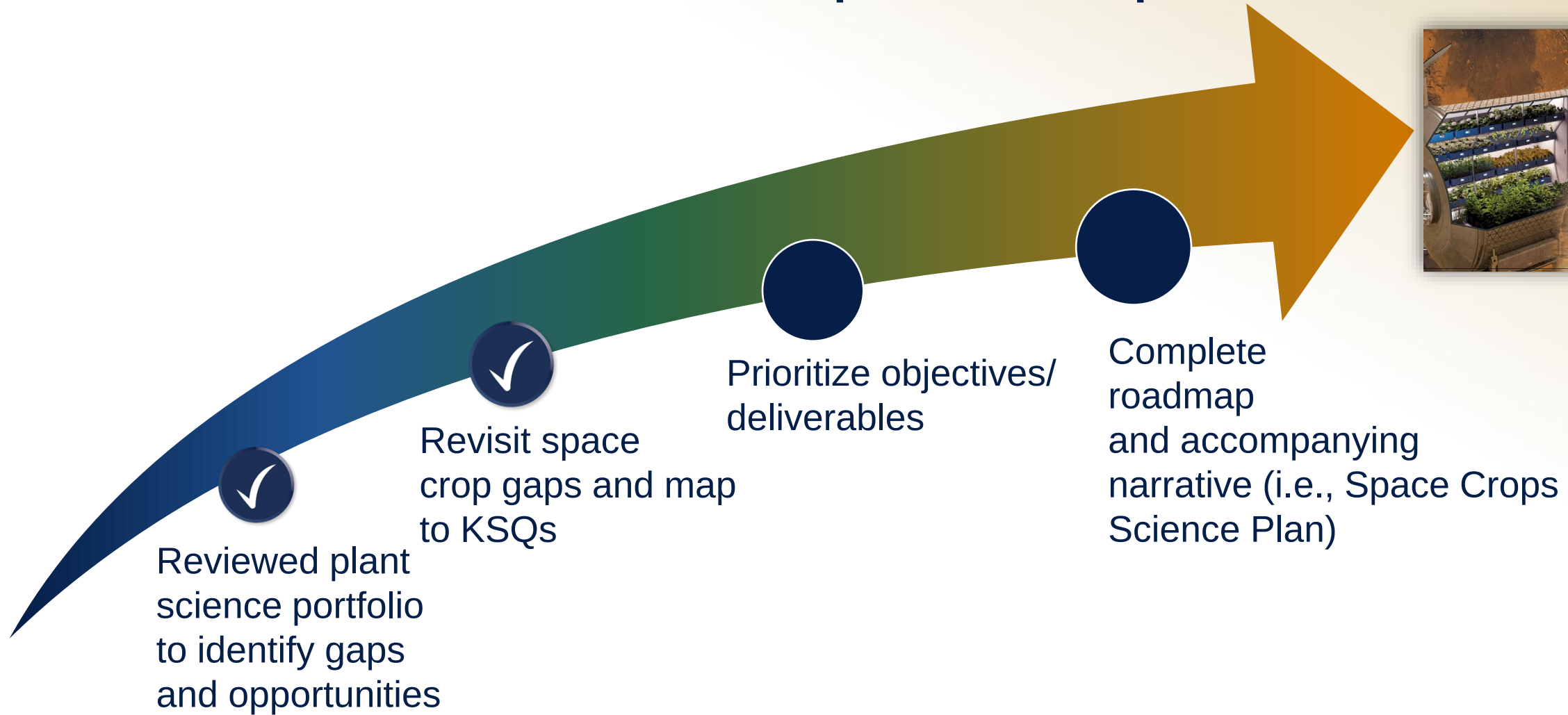
- Novel stress protective function of plant telomeres discovered during spaceflight
- Increased virulence of bacteria in space is partly caused by upregulation of quorum sensing
- Wearable sensors for monitoring ethylene and plant growth developed
- Plants adapt well to the space environment, and to date, space-grown crops are safe to eat, nutritious, and highly acceptable to astronauts

Thriving in Space

Revolutionary research in extraordinary places.



Goal Overview: Space Crops



Decadal and Moon to Mars (M2M) Alignment : Space Crops

Most Relevant Decadal Themes and Research Campaign

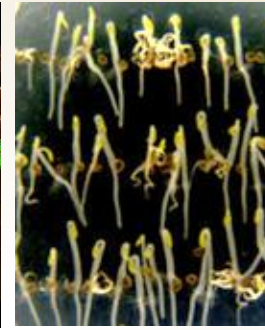
- Advances the Adapting to Space and Living and Traveling in Space Themes.
 - Transition to/from space
 - Genetic diversity & life history
 - Interactions between organisms
 - Multigenerational effects
 - Integration of biological & abiotic systems
 - Behavior of fluids in space
- Advances the Bioregenerative Life Support Systems (BLISS) research campaign.

Most Relevant M2M Objectives

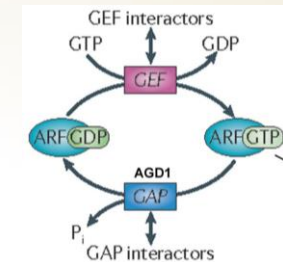
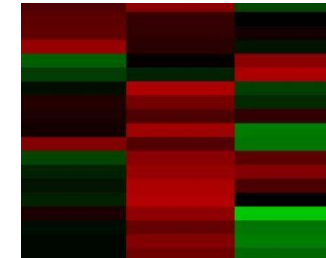
- HBS-1LM - Understand the effects of short- and long-duration exposure to the environments of the Moon, Mars, and deep space on biological systems and health, using humans, model organisms, systems of human physiology, and plants.
- AS-5LM: Define crop plant species, including methods for their productive growth, capable of providing sustainable and nutritious food sources for lunar, Deep Space transit, and Mars habitation.

Examples of guiding questions for roadmapping

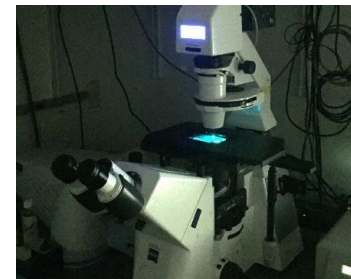
- What role will model plants play?



- How do we make a leap from primarily descriptive science to more mechanistic understanding of plant biological processes in space?



- What are top technological needs and science questions that need to be answered to successfully grow crops in space?



Relevance to Decadal Survey

GAPS

- Environmental Control
- Plant Environmental Response
- Crop Performance
- Horticultural Practice
- Produce Safety

SUB-GAPS (from >60)

- Water/Nutrient Delivery
- Gravity
- Radiation
- Atmosphere
- Yield
- Harvest Index
- Seed handling
- Harvesting
- Microbiome

RELEVANT KSQs

- KSQ1 – Space environment influence on biological mechanisms (e.g., xylem structure and hydraulics, nutrient uptake)
- KSQ7 – Phenomena that govern behavior of fluids in space environments



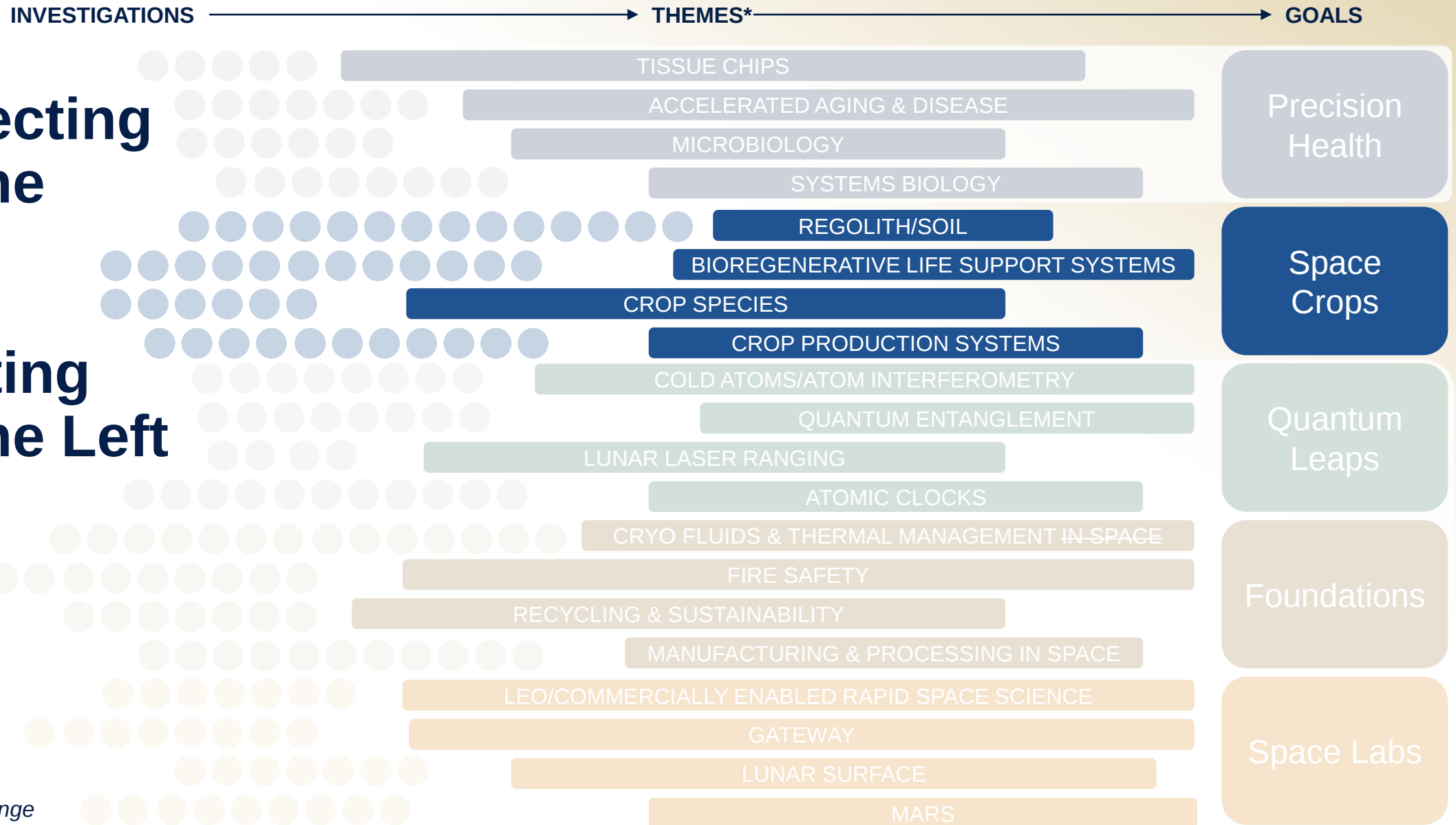
Progress with Space Crops Roadmapping

Objective:

Lunar Crops for Whole Food Nutrition and Mental Well-Being

- Define subobjectives/disciplines – Plant/Crop Physiology, Ecology, Microbiology, Molecular biology
- Prioritize space stressors – partial gravity, magnetic fields, radiation, growth substrates
- Define measurable outcomes – metrics that indicate progress toward an objective. How do we know if we are achieving the objective?

Architecting from the Right, Executing from the Left



*Draft – subject to change

Space Crops Vision

