Introduction to NASA, the Science Mission Directorate, and Space Biology

National Aeronautics and Space Administration

GL4U: Introduction 2024
Lecture 1 of 4

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NASA GeneLab Science Lead

Contractor: KBR

Biological & Physical Sciences

Acknowledgements

Open Science for Life in Space Teams

Open Science Analysis Working Group Members

Support

NASA Space Biology Program
NASA Science Mission Directorate
NASA Human Research Program
NASA Biological and Physical Sciences

Introduction to the National Aeronautics and Space Administration (NASA)

A Brief History of NACA

1903 Wright Brothers first flight

1915 NACA established

1917 Langley established

1940 Lewis (Glenn) established

1942 Ames established

1946 First supersonic flight

1947 Dryden (Armstrong) established

1950s NACA begins to look into the possibility of manned spaceflight

1957-8 Plan established to orbit a scientific satellite

https://www.nasa.gov/ames/the-national-advisory-committee-for-aeronautics

A Brief History of NASA

1957 — Soviet Union launches Sputnik 1

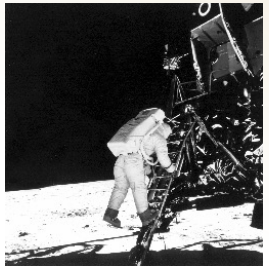
1958 — *'An Act to provide for research into the problems of flight within and outside the Earth's atmosphere, and for other purposes.'*

1958 — NASA established and absorbs itself into NACA

1961-3 — US launches it's first Earth satellite

1965-6 — **Mercury**'s single astronaut program: Can humans survive in space?

1968-72 — **Project Gemini**: Two astronauts practice space operations



1981 — **Project Apollo**: Explore the Moon

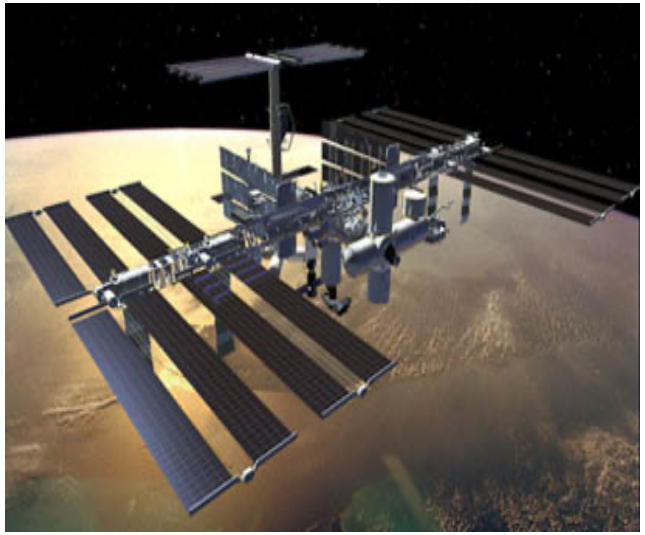
1984 — Space Shuttle's first mission: STS-1

2011 — Congress authorized NASA to build the Space Station

Last Space Shuttle Mission: STS-135

NASA's Vision

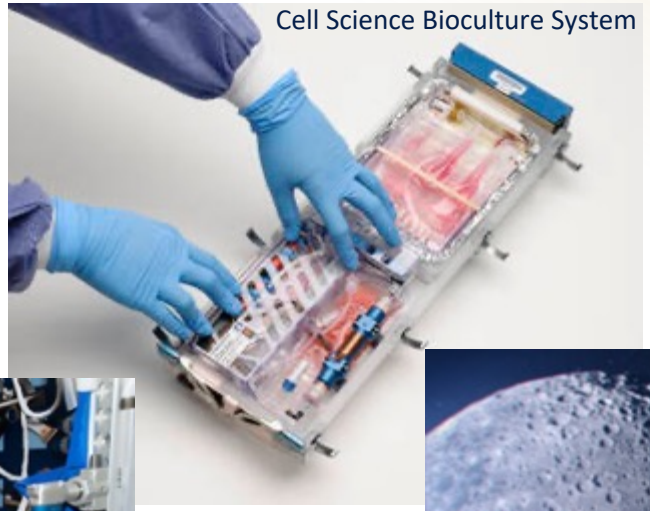
To reach for new heights and reveal the unknown for the benefit of humankind



NASA's Mission

To drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality and stewardship of Earth

https://www.nasa.gov/content/the-crawlers



Cell Science Bioculture System

NASA astronaut Christina Koch

https://www.nasa.gov/gateway/

How does NASA achieve its Mission?

- **NASA HQ** – Provides overall guidance and direction to the Agency
- **NASA Centers and Facilities** – Where the day-to-day NASA work is performed in laboratories, airfields, wind tunnels, etc.
- NASA conducts its work though six main organizations called **Mission Directorates**:

Space Operations (SOMD)

Exploration Systems Development Mission Directorate (ESDMD)

Space Technology (STMD)

Science (SMD)

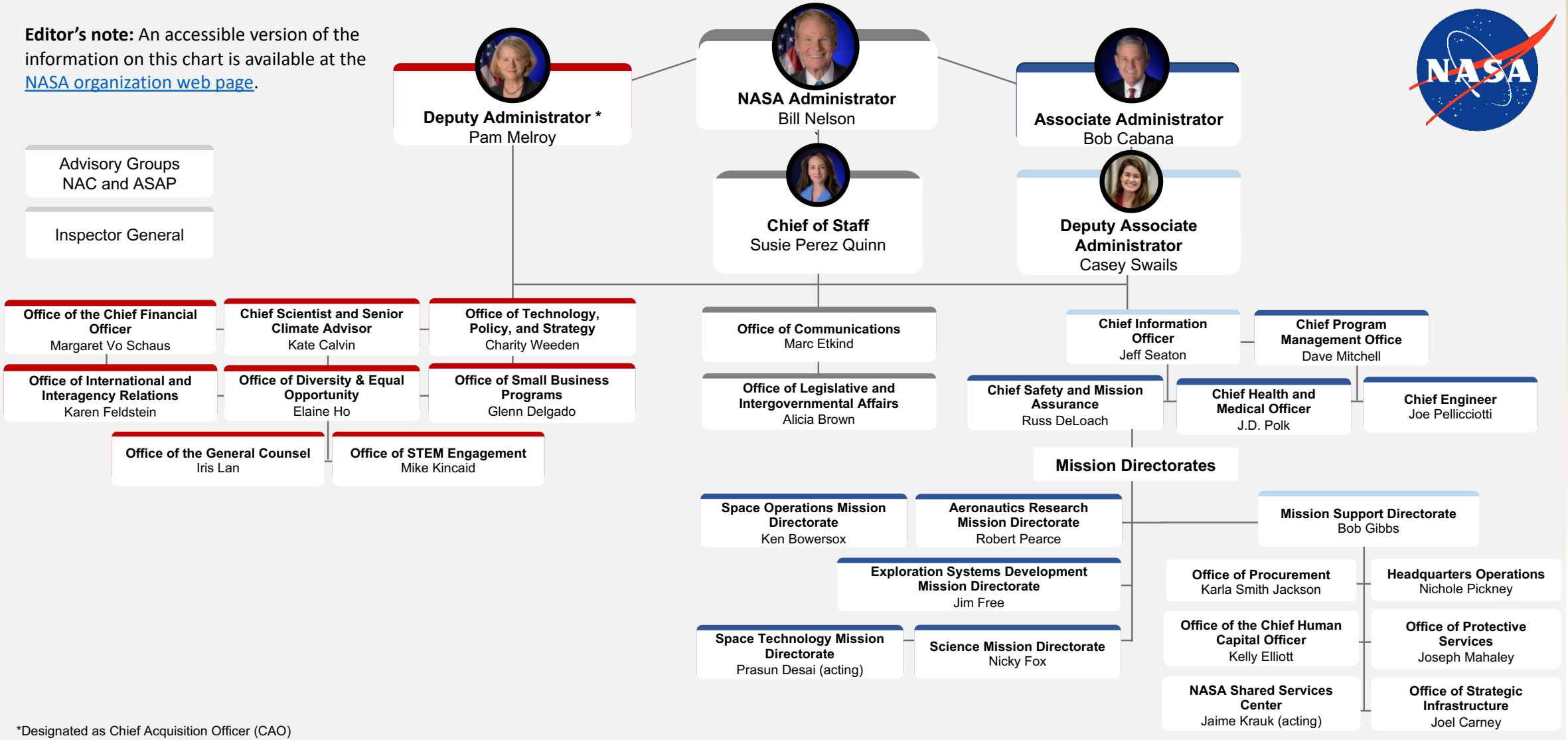
Mission Support (MSD)

Aeronautics Research (ARMD)

https://www.nasa.gov/directorates/

NASA Organization

Editor's note: An accessible version of the information on this chart is available at the NASA organization web page.



*Designated as Chief Acquisition Officer (CAO)

JPL is a Federally Funded Research and Development Center (FFRDC

Current as of Oct. 18, 2023

https://www.nasa.gov/organization/

NASA Leadership

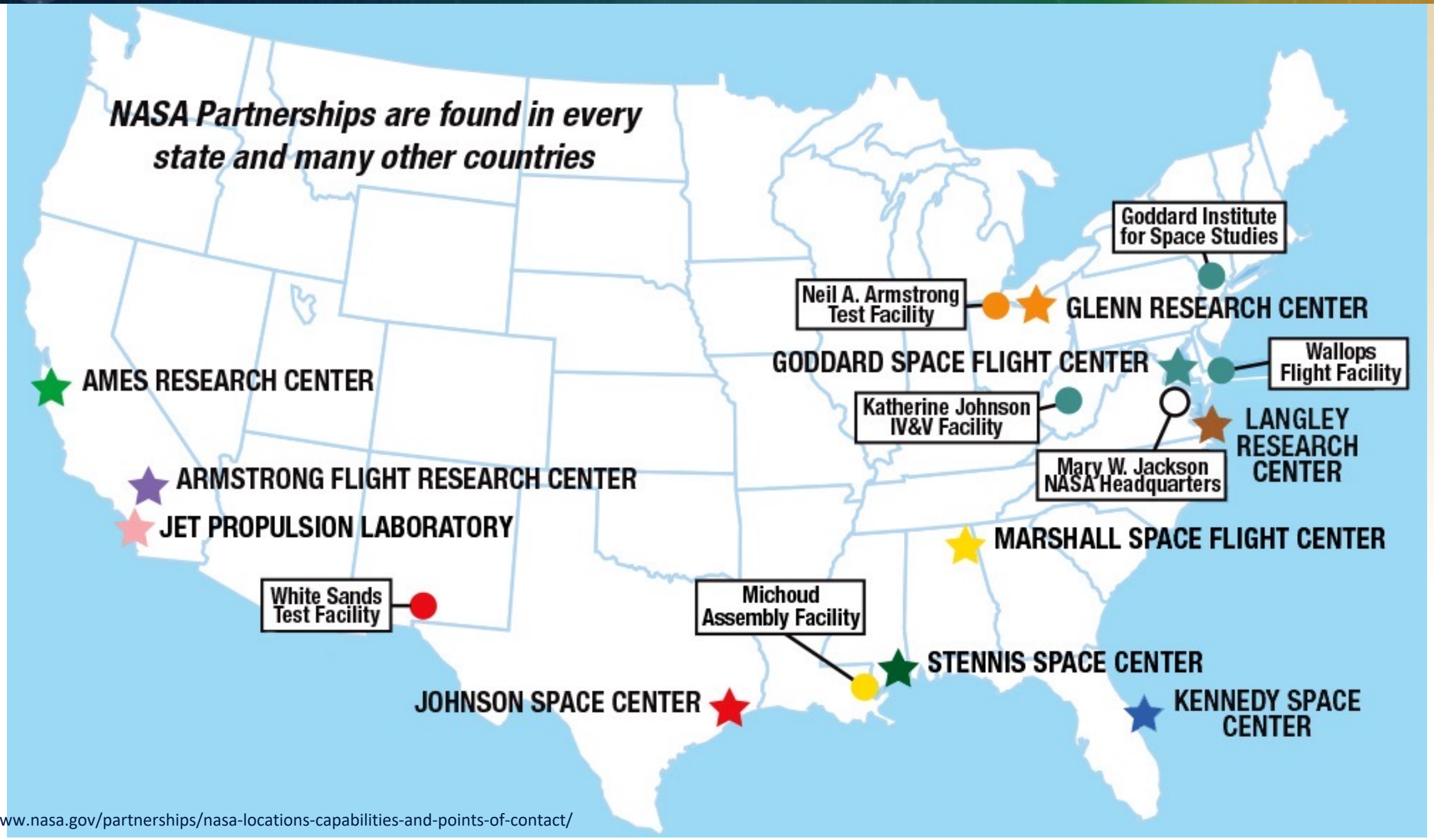
Administrator: Bill Nelson

Sen. Bill Nelson was sworn in as the 14th NASA administrator on May 3, 2021, tasked with carrying out the Biden-Harris administration's vision for the agency. Nelson served in the U.S. Senate for 18 years from Florida and as a payload specialist on space shuttle mission 61-C in 1986. Bill Nelson's full bio: https://www.nasa.gov/people/nasa-administrator-bill-nelson/

Deputy Administrator: Pamela Melroy

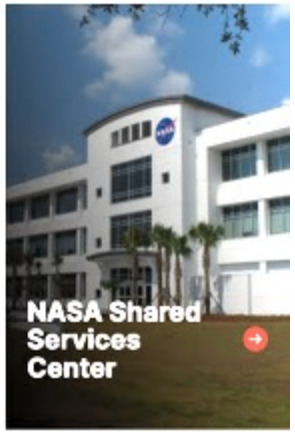
One of only two women to command a space shuttle, Melroy logged more than 38 days in space. All three of her missions were assembly missions to build the International Space Station. After serving more than two decades in the Air Force and as a NASA astronaut, Melroy took on a number of leadership roles, including at Lockheed Martin, the Federal Aviation Administration, the Defense Advanced Research Projects Agency, Nova Systems Pty, Australia, and as an advisor to the Australian Space Agency. She currently is an independent consultant and a member of the National Space Council's Users Advisory Group. Pam Melroy's full bio: https://www.nasa.gov/people/nasa-deputy-administrator-pam-melroy/

NASA Centers and Facilities



https://www.nasa.gov/partnerships/nasa-locations-capabilities-and-points-of-contact/

NASA Centers and Facilities



https://www.nasa.gov/centers-and-facilities/

What has NASA done for life on Earth?

Spinoffs from Mars!

NASA has been exploring Mars since the 1960s, pushing the frontier of innovation to get to the red planet and discover its secrets. This new technology has often found other uses here on Earth as well. A few highlights:

Generating Wind Power

Solar power is great until a Martian dust storm blacks it out. But there's another option for those blustery days: wind power. NASA helped design a low-maintenance wind turbine that can function in extreme conditions – on Mars or on Earth.

Guiding Cars with Tech for Mars

Autonomous navigation on Mars requires "brains" made up of advanced neural networks and deep learning algorithms. But if the rovers can manage on another planet, putting the same tech in cars, drones, and toys here on Earth is a no-brainer.

To learn more, visit: spinoff.nasa.gov/mars

Suturing with Mars-Grade Materials

Bringing home a Martian sample requires a perfectly sealed container to prevent contamination. A soft, flexible, strong material keeps Martian dust from interfering with the seal and is great for heart surgery sutures and stents.

Detecting Methane Leaks

To search for life on Mars, we look for clues – like methane, which is usually created by microbes. But tools to sniff out tiny traces of methane on Mars now help detect leaks in natural gas pipelines on Earth.

Carbonating Beer

Technology created to fuel a journey home from Mars (now helping recycle methane from oil drilling) also found another use on Earth: capturing carbon dioxide emitted by fermenting hops and using it to put the bubbles in beer.

https://www.jpl.nasa.gov/news/nasas-perseverance-pays-off-back-home/

What has NASA done for life on Earth?

More NASA Tech Helping to Solve Climate Challenges

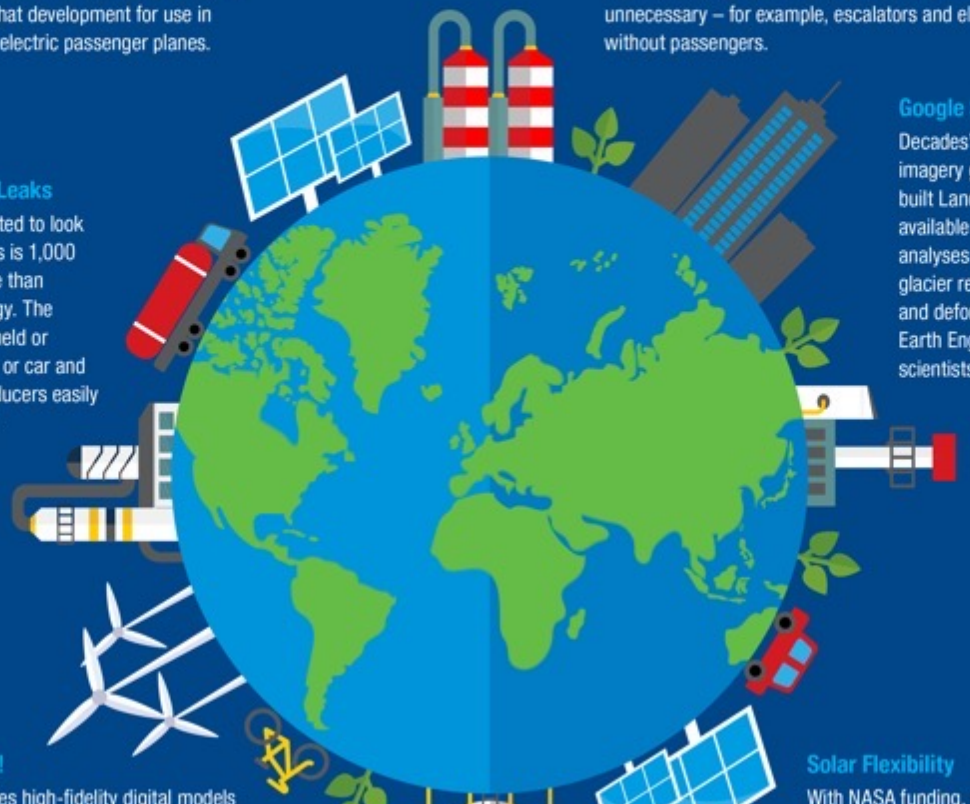
NASA research and innovations have led to more environment-saving spinoffs than we can count. Besides the ones described in this feature, here are a handful of additional technologies helping curb greenhouse gas emissions, advance renewable energy technologies, and better understand the processes leading to warming.
For more, visit spinoff.nasa.gov/climate-change

All-Electric Flight

With NASA's help, a company designed a high-power battery pack that could meet safety requirements for the agency's all-electric experimental airplane. Now the company is selling batteries based on that development for use in some of the first all-electric passenger planes.

Running on Empty

The voltage controller, invented by a NASA engineer in the 1970s, is one of NASA's most-used innovations. It enables machinery to automatically decrease energy consumption when full power is unnecessary – for example, escalators and elevators without passengers.



Google Searches Earth

Decades' worth of Earth imagery gathered by the NASA-built Landsat satellites is now available for free, enabling global analyses of surface trends like glacier retreat, desertification, and deforestation. Google Earth Engine is partnering with scientists to mine all that data.

Sniffing Out Gas Leaks

A spectrometer created to look for methane on Mars is 1,000 times more sensitive than competing technology. The device can be handheld or mounted on a drone or car and lets natural gas producers easily spot and stop leaks.

Send In the Clone!

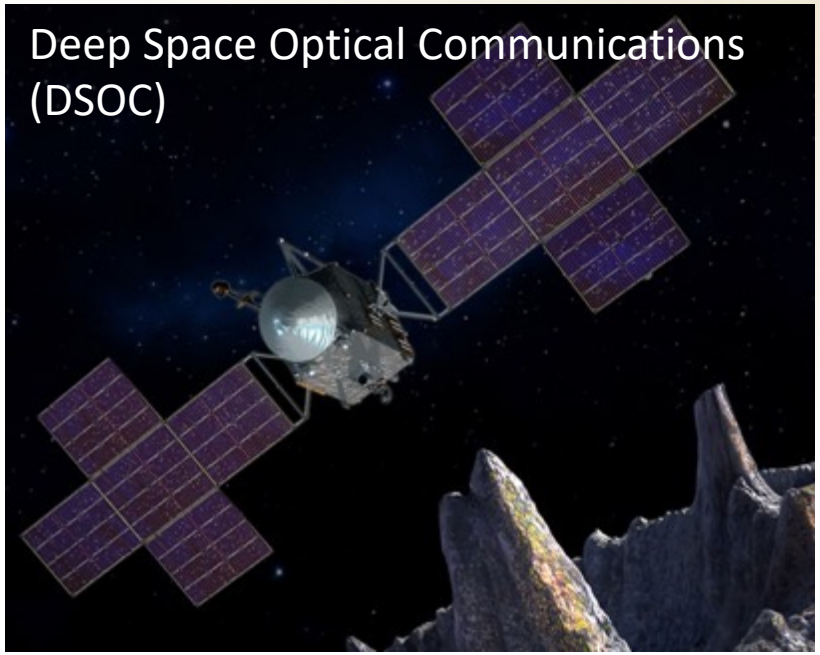
A program that creates high-fidelity digital models – or "clones" – of mechanical components or systems was validated against years' worth of NASA helicopter gear data. Now it allows some of the country's largest wind turbine operators predict and extend their turbines' lifespans

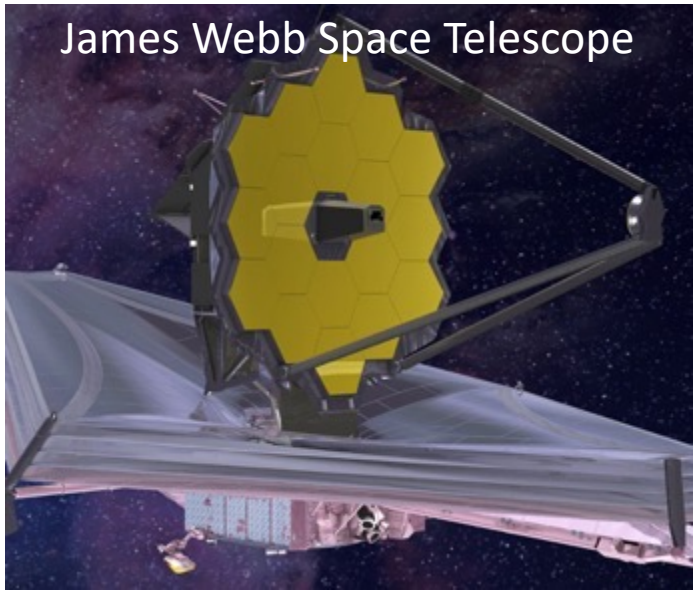
Solar Flexibility

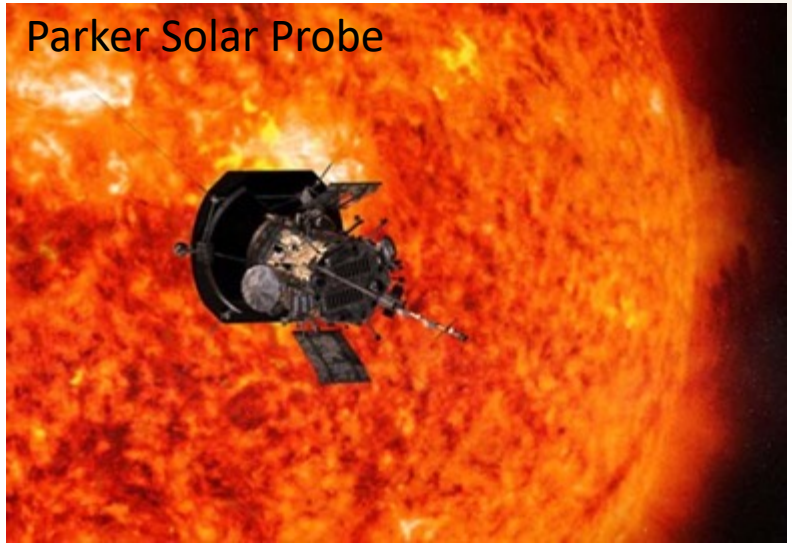
With NASA funding, one company developed a cheaper way to produce high-efficiency solar cells and used it to make affordable, portable, flexible solar panels. Its solar cells now power troops' devices in the field, as well aircraft and satellites.

https://science.nasa.gov/earth/climate-change/nasa-technologies-spin-off-to-fight-climate-change/

What's in store for NASA?



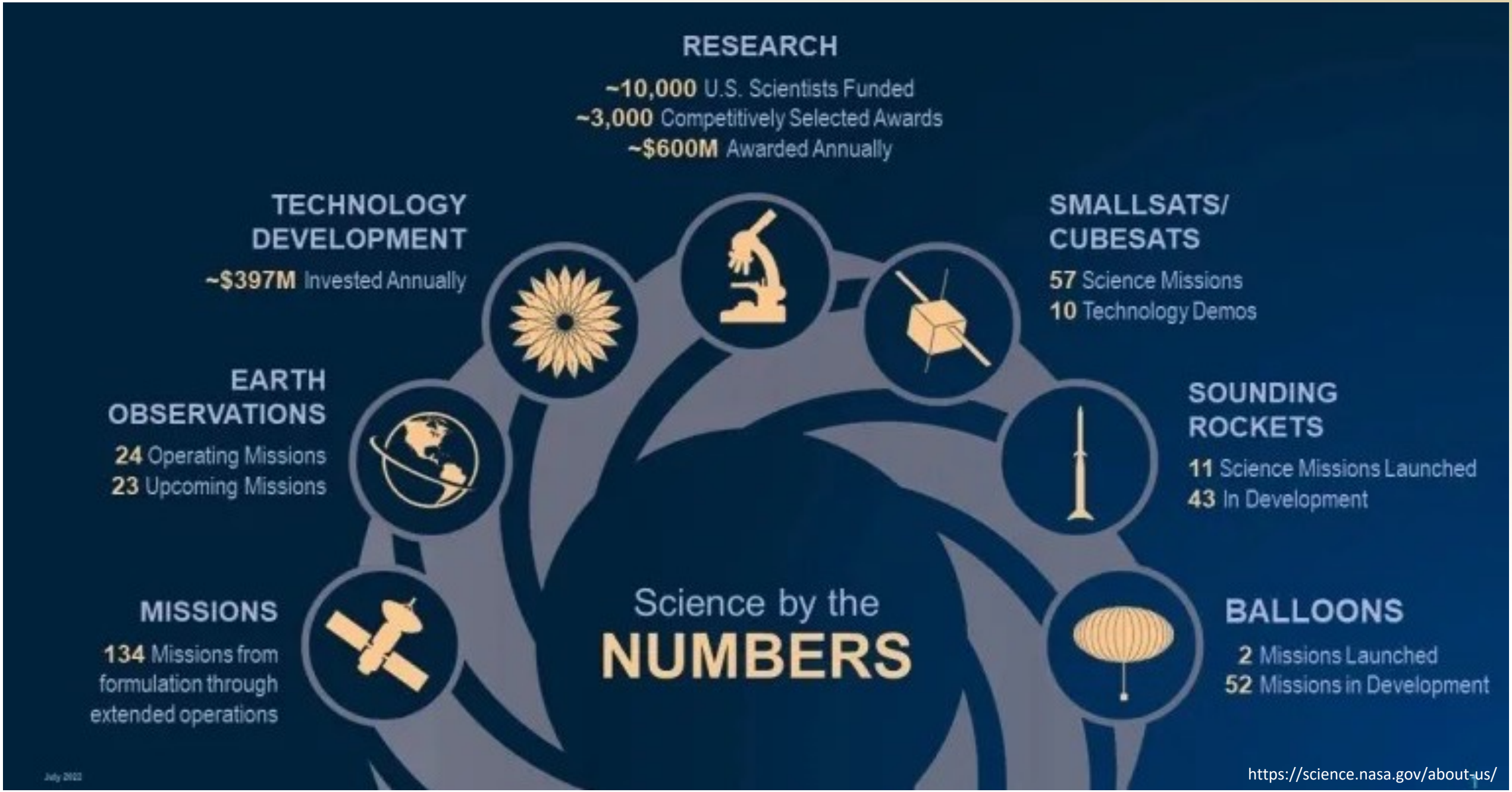




https://www.nasa.gov/specials/60counting/future.html

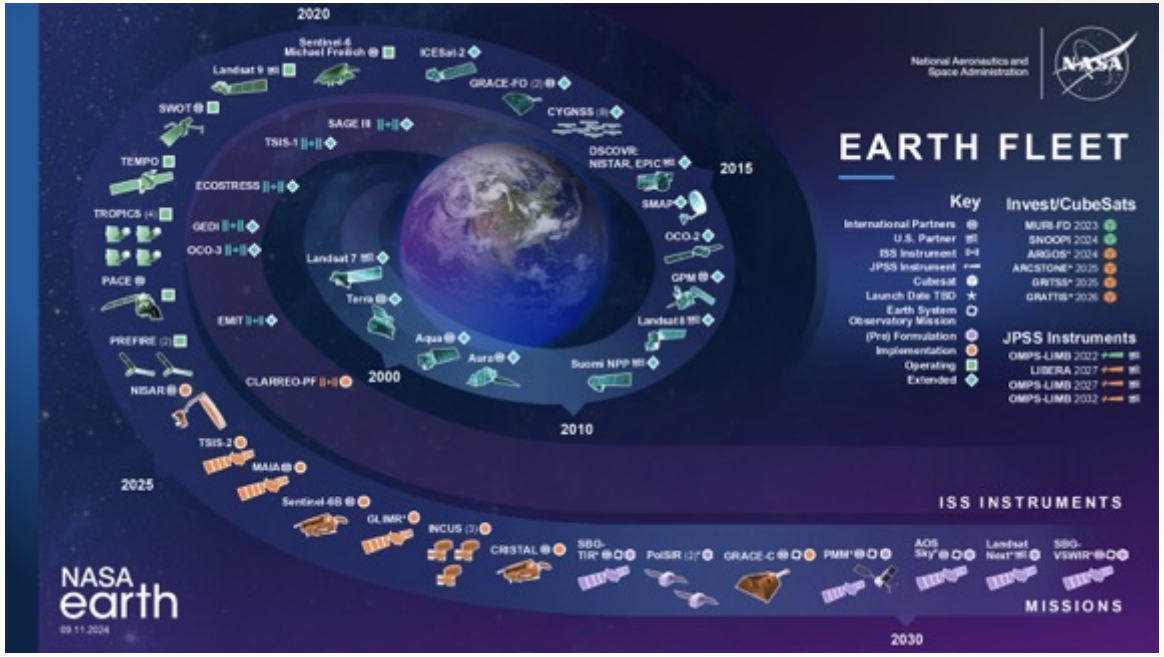
Introduction to NASA SMD, BPS, and Space Biology

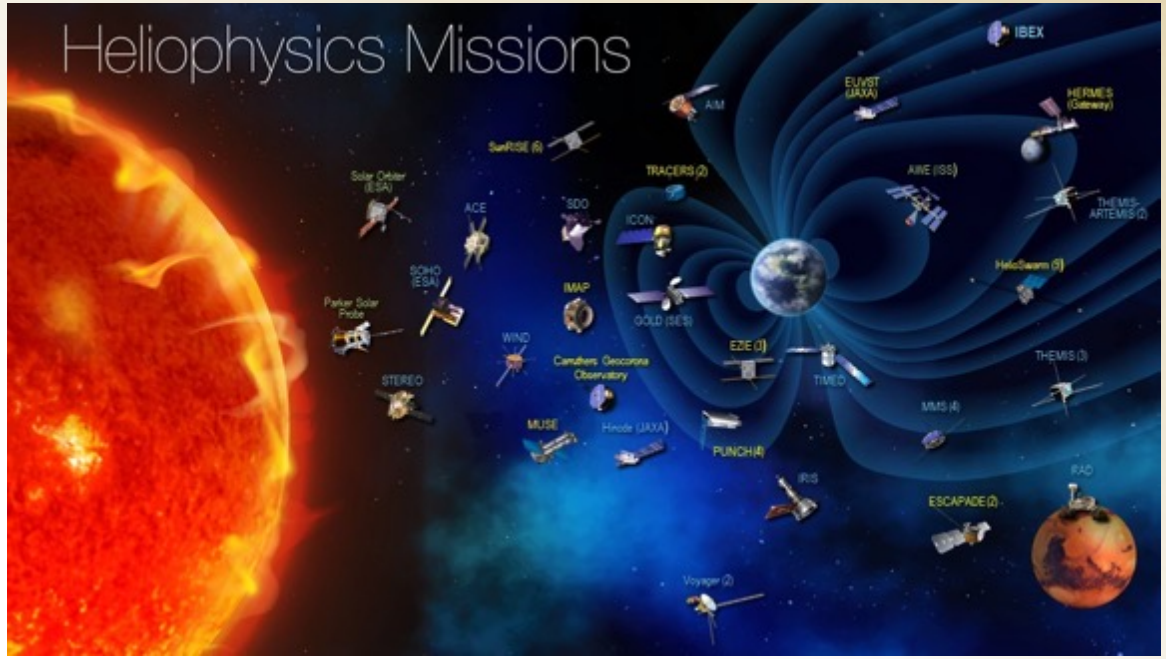
NASA SMD Science by the Numbers

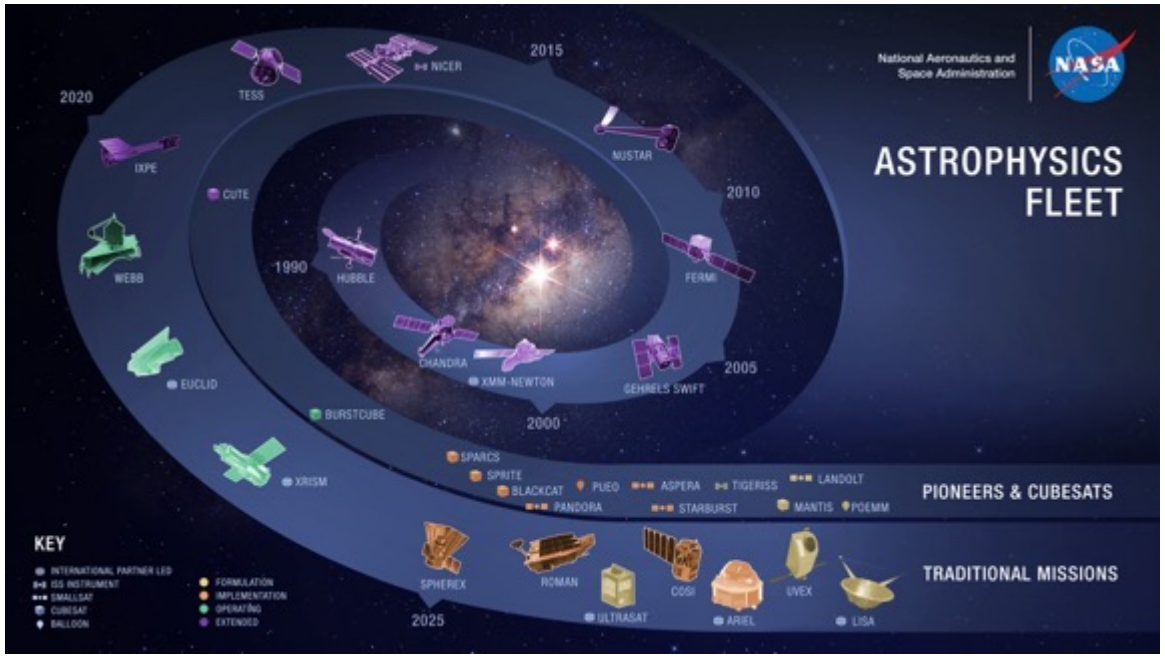


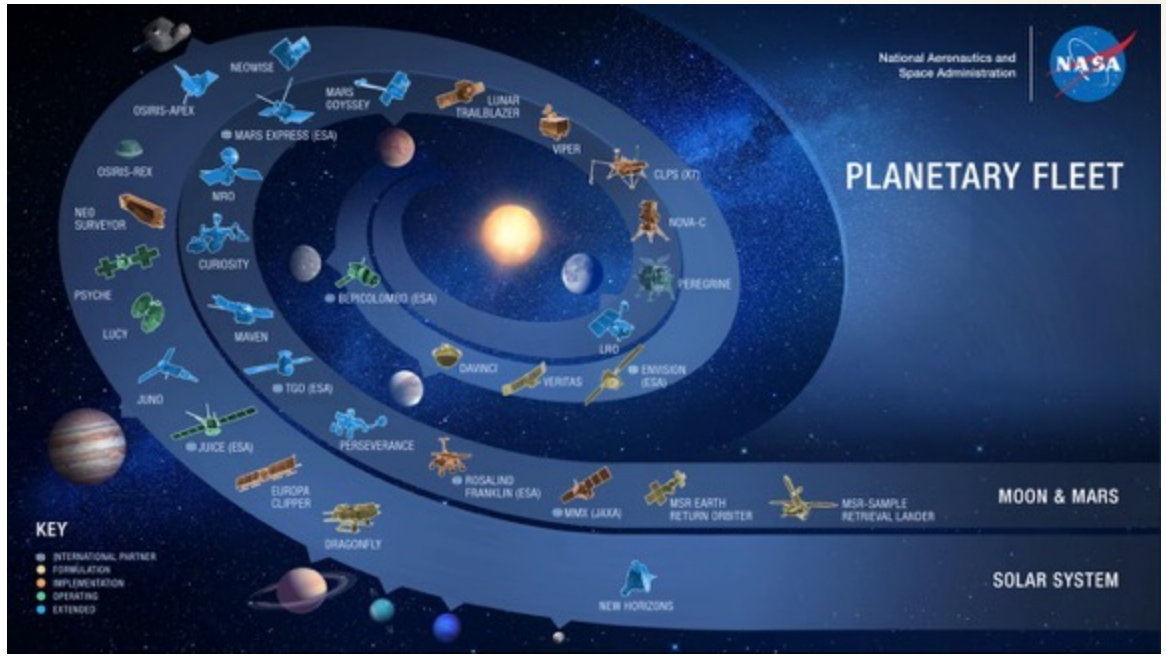
https://science.nasa.gov/about-us/

NASA Science Mission Directorate (SMD)

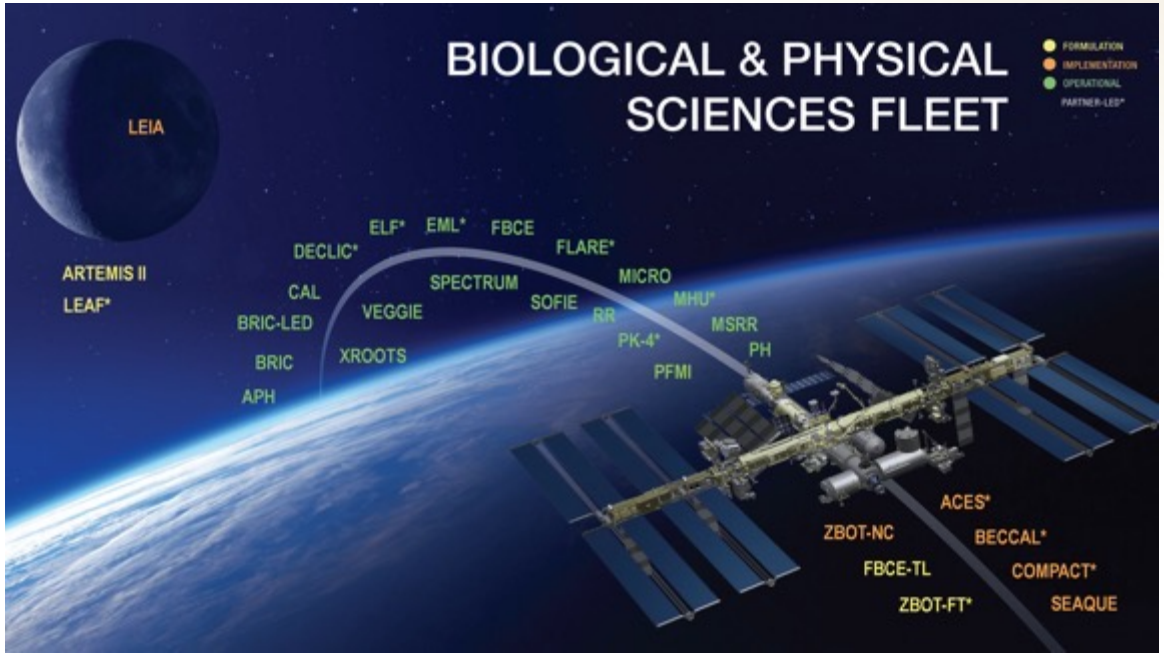


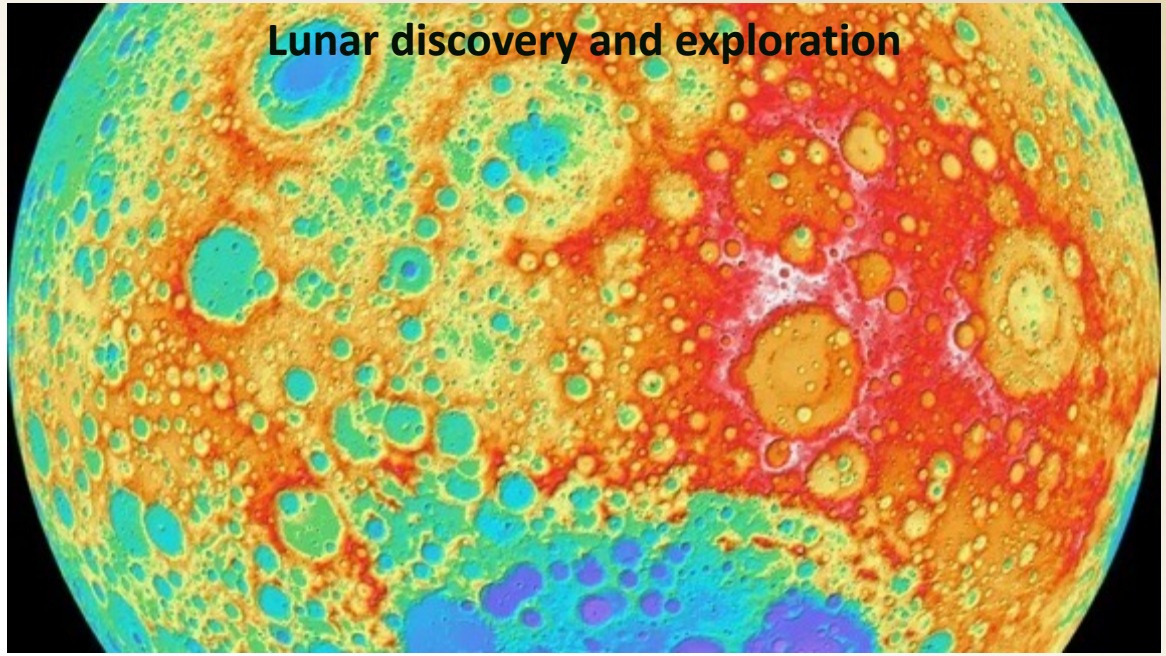


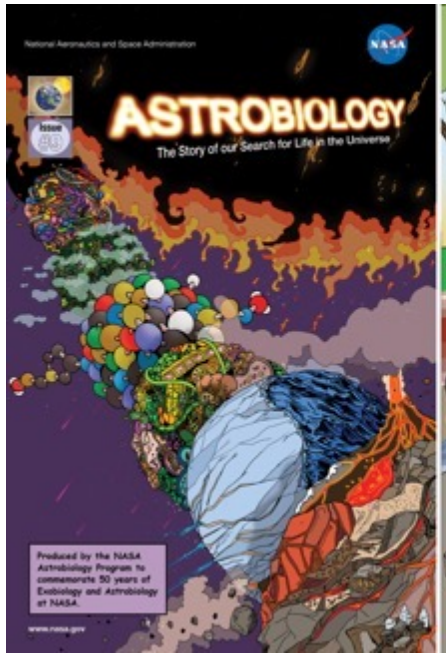


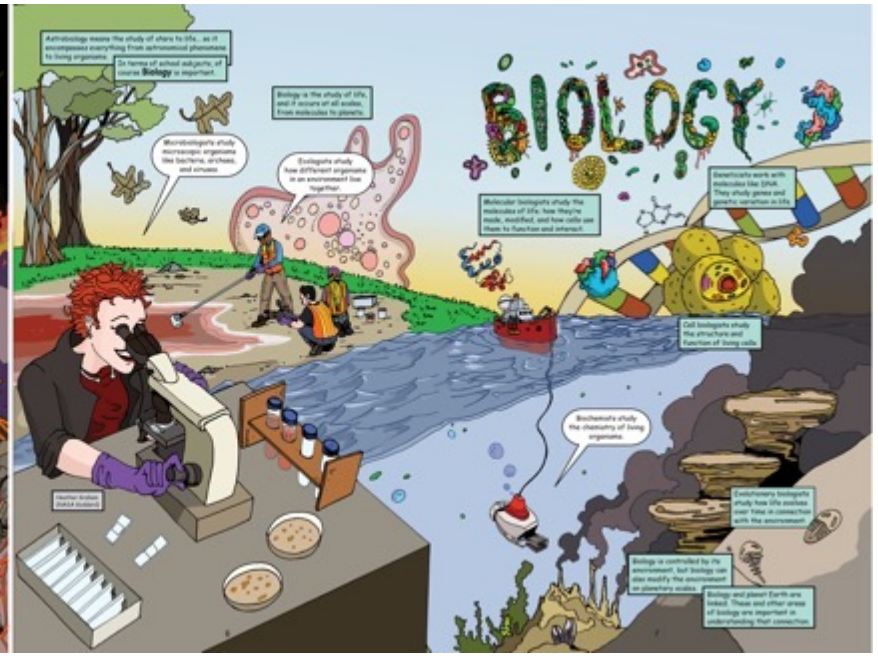


NASA Science Mission Directorate (SMD)

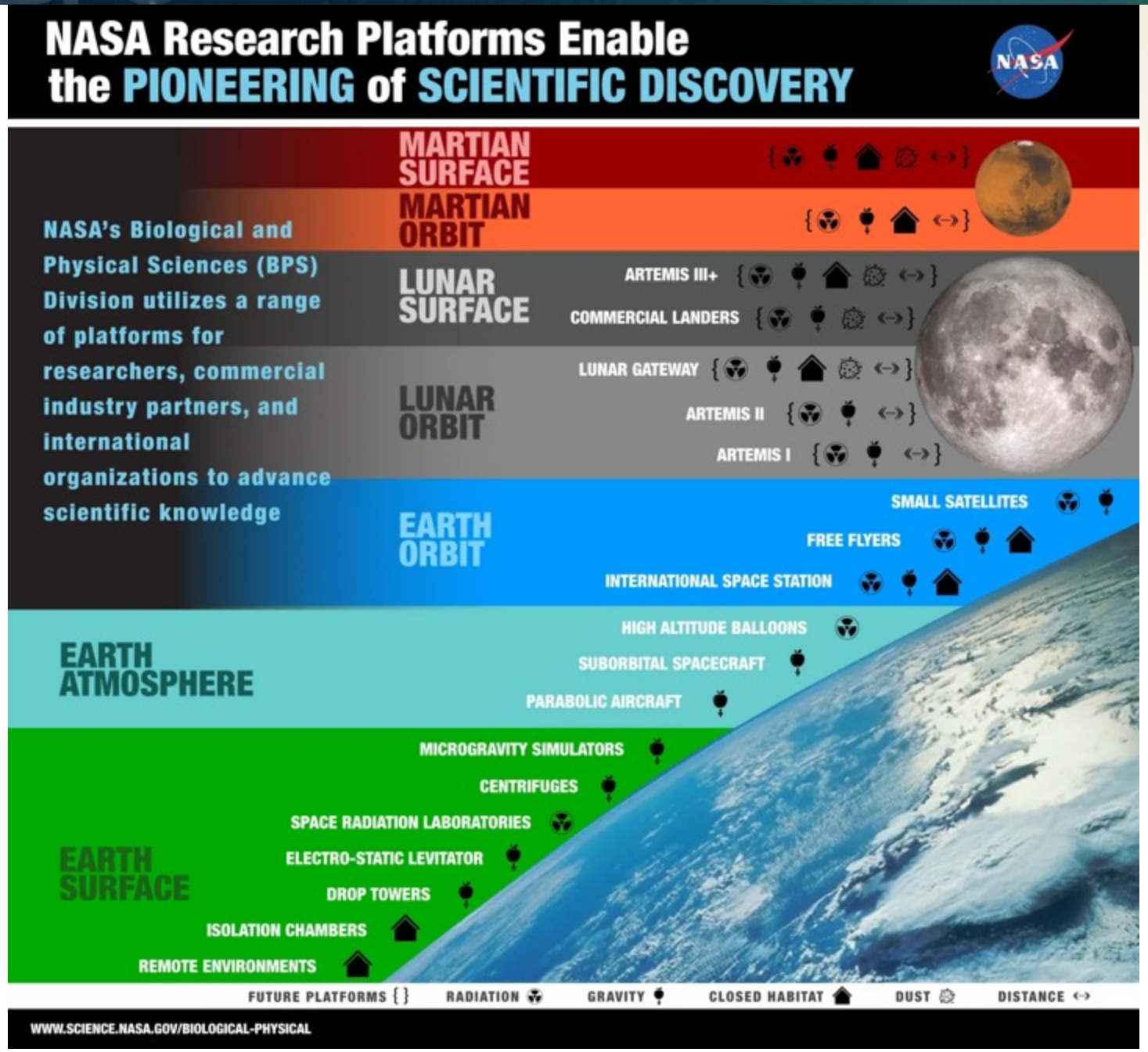








NASA SMD: Biological and Physical Sciences (BPS)

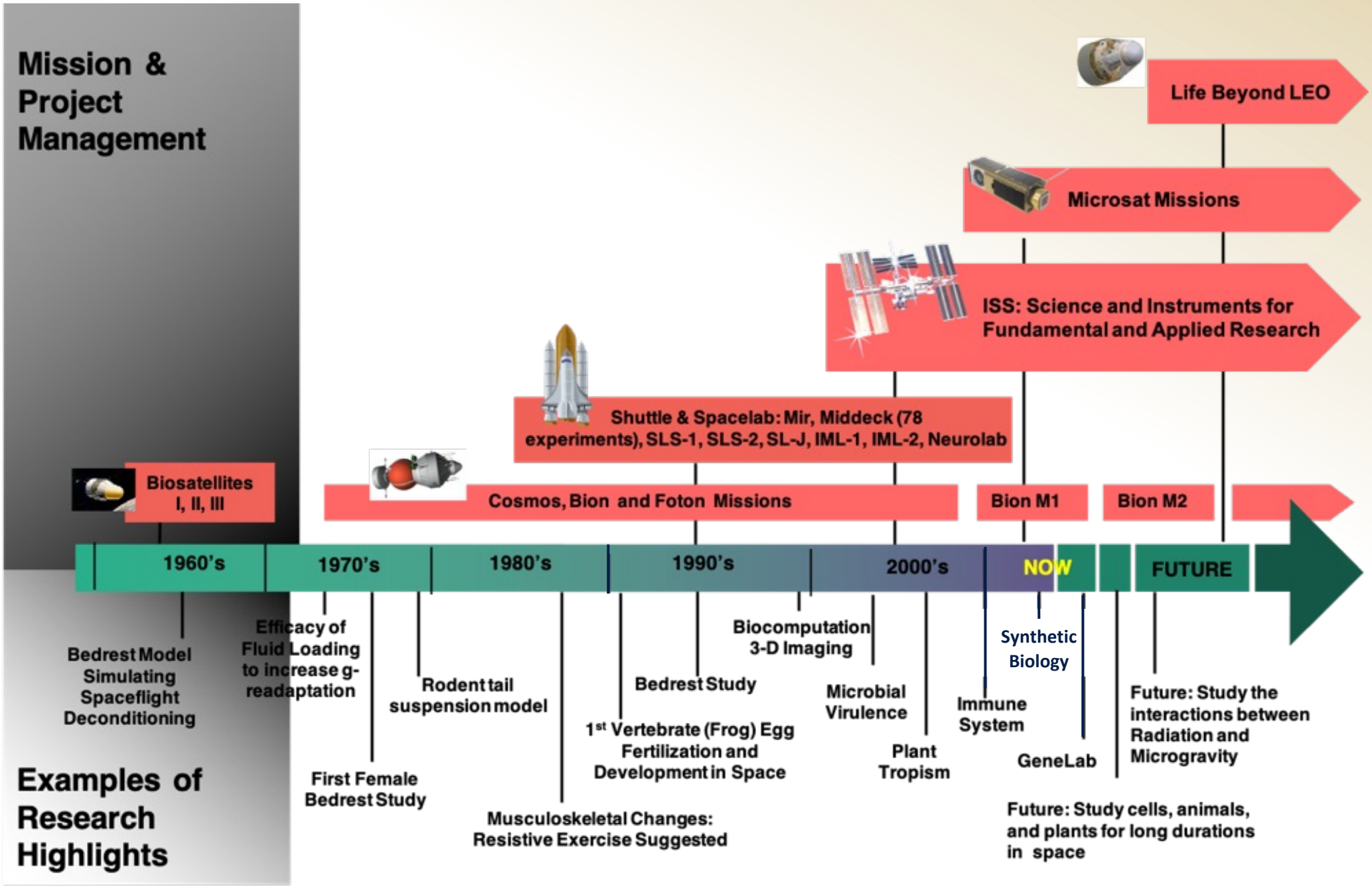


BPS Mission:

- Pioneer scientific discovery in and beyond low Earth orbit to drive advances in science, technology, and space exploration to enhance knowledge, education, innovation, and economic vitality
- Enable human spaceflight exploration to expand the frontiers of knowledge, capability, and opportunity in space

https://science.nasa.gov/biological-physical/

5+ Decades of NASA Life Sciences Research



Exposure to Spaceflight Changes our Physiological Systems

The Musculoskeletal System

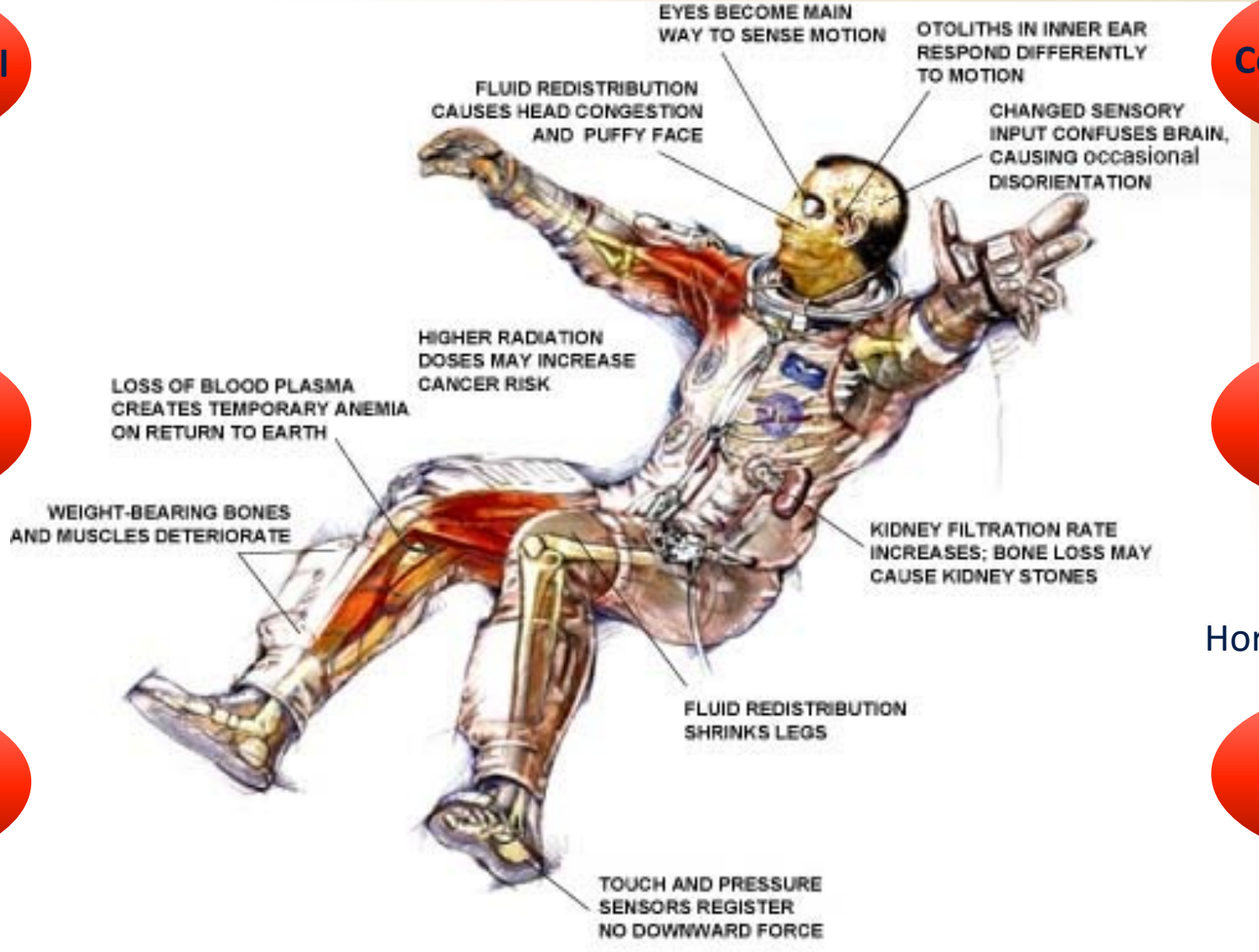
Osteoporosis
Osteoarthritis
Muscle atrophy

The Cardiovascular System

CVD
Atherosclerosis
Anemia

The Lymphatics

Lymphatic pump disorders



The Central Nervous System

Memory loss
Retinal edema

The Reproductive System

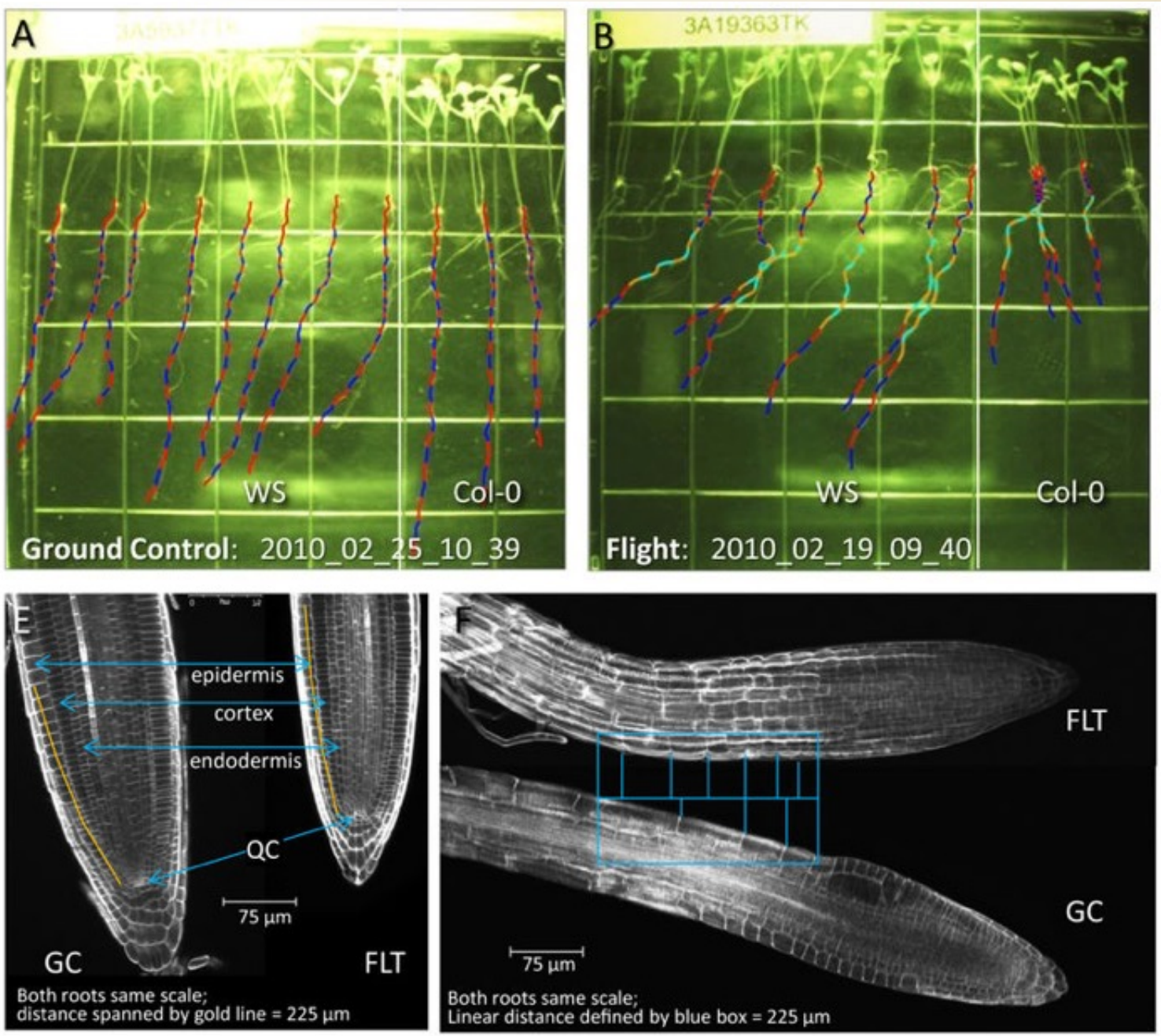
Sperm motility
Infertility
Hormonal imbalances

The Digestive System

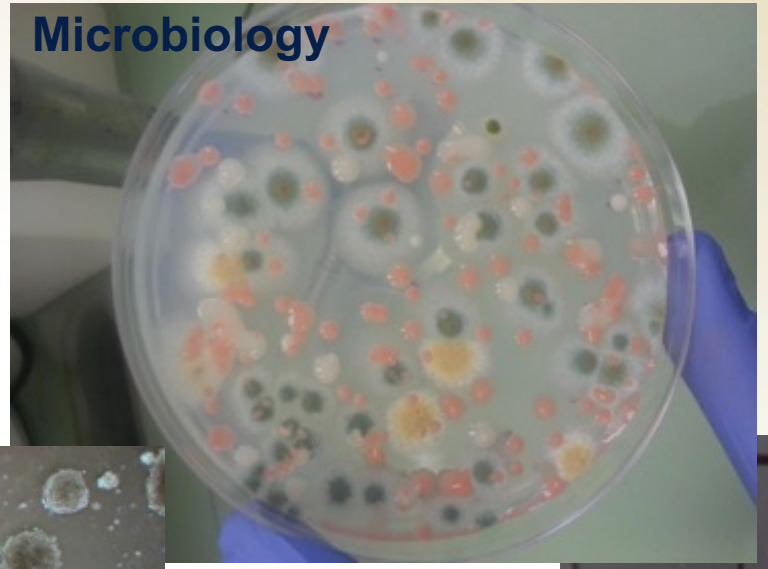
Liver fibrosis
NAFLD
IBS
Microbiome

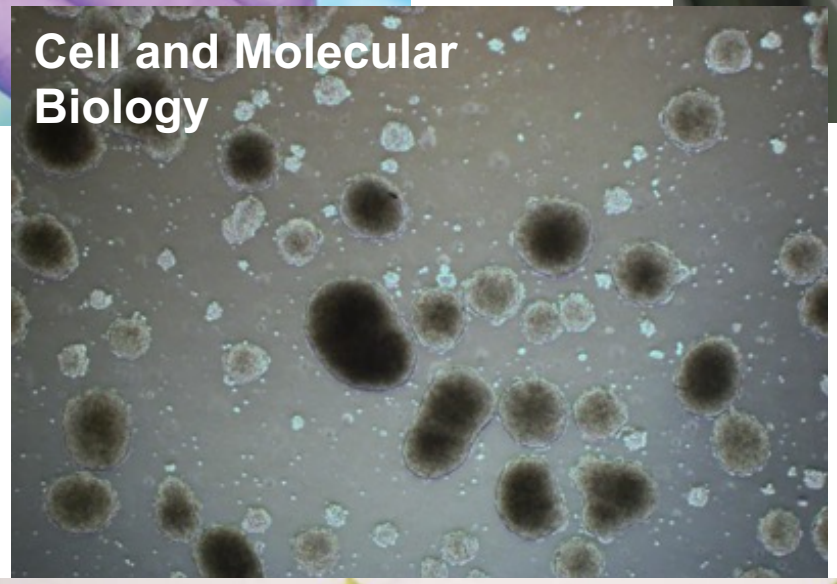
Astronaut image retrieved from http://marinscienceseminar.com/space-travel-how-does-outer-space-affect-your-body/

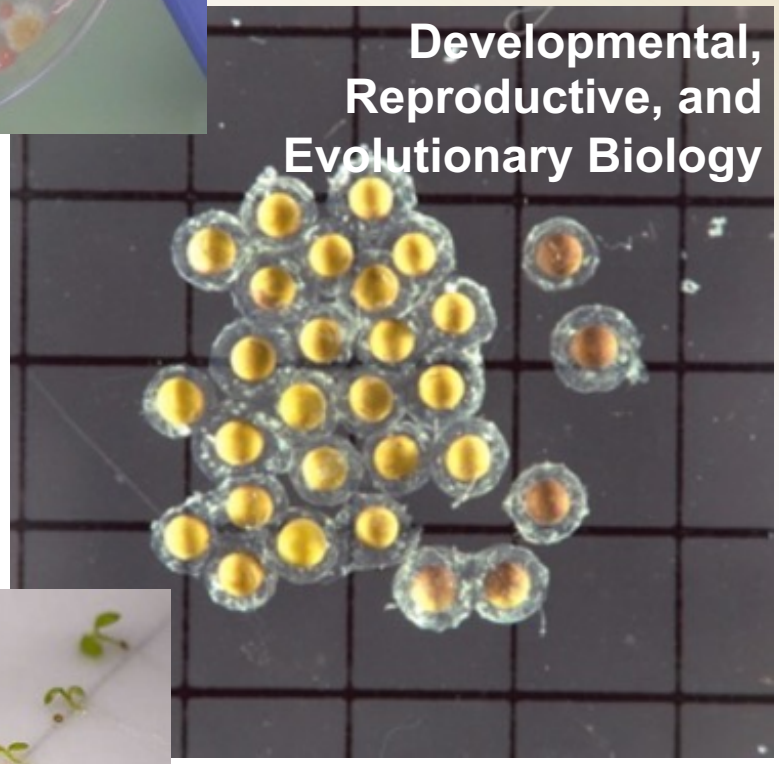
Exposure to Spaceflight Changes Plant Physiology Too

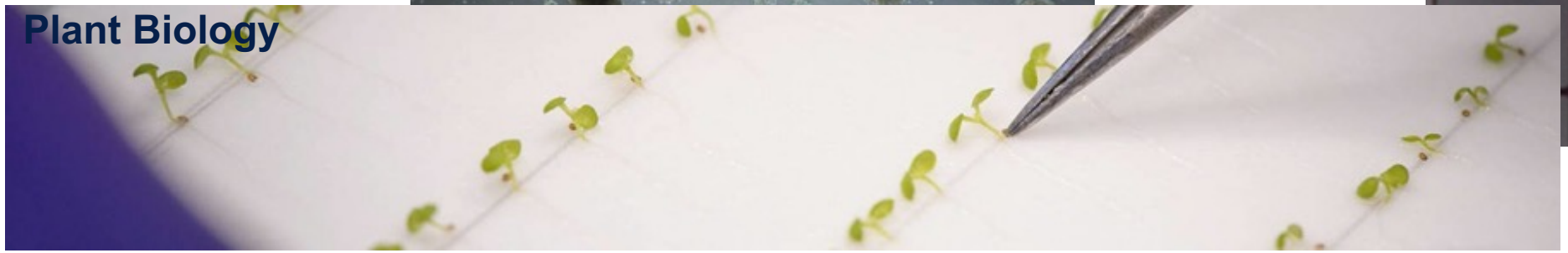


Space Biology Program







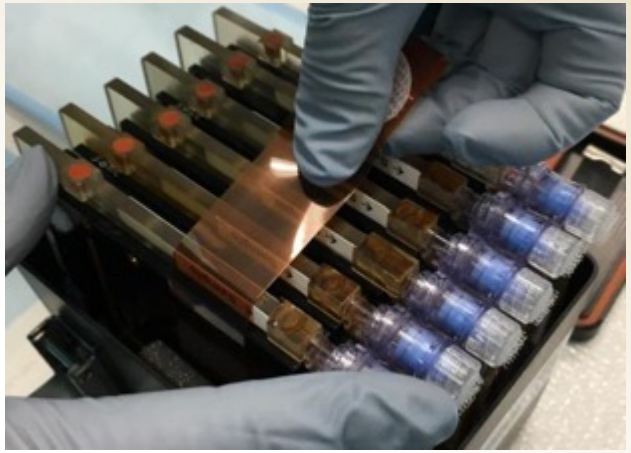


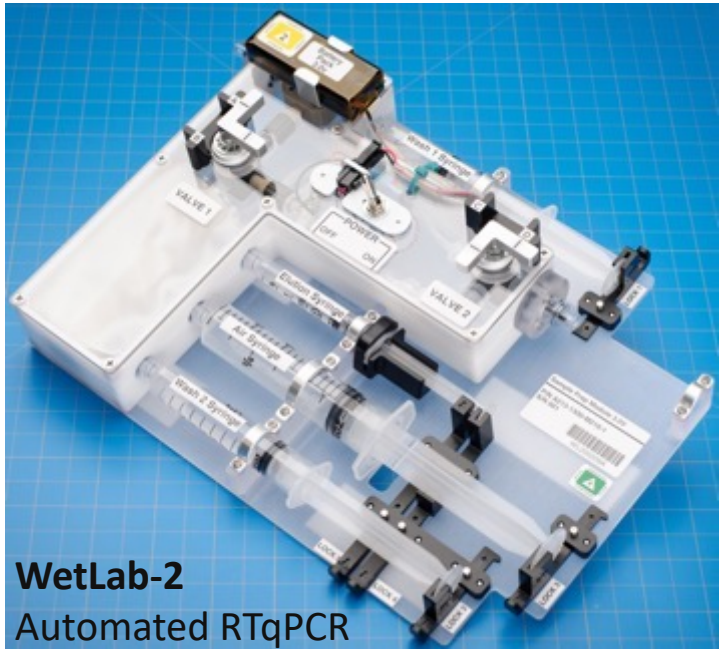
https://science.nasa.gov/biological-physical/programs/space-biology

Spaceflight Hardware: Cell Culture Systems

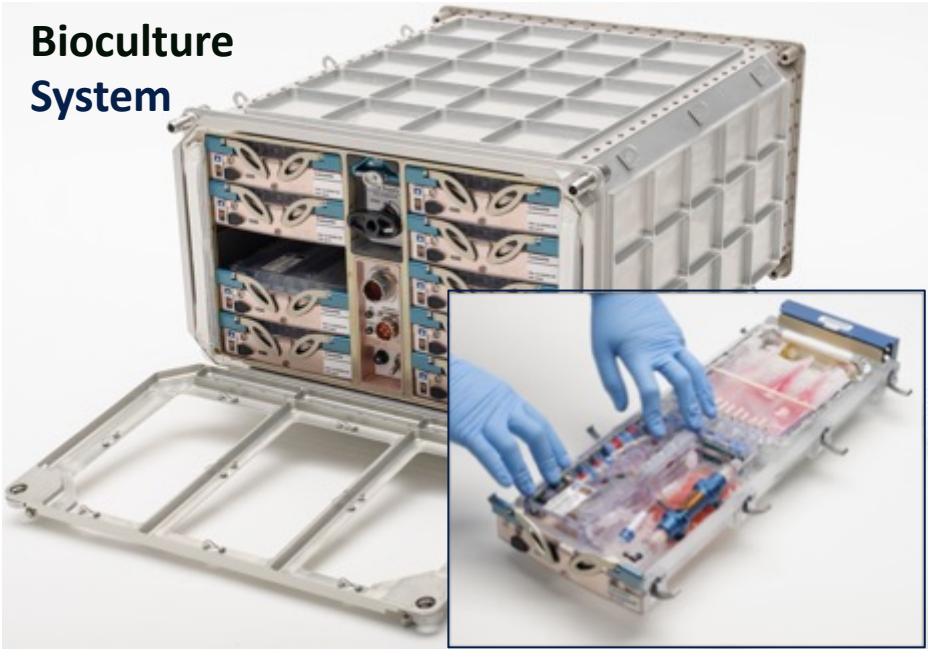
BioCell Research Applications

- Mammalian cells/tissues
- Small organisms (e.g., *C. elegans*)
- Yeast, bacteria, fungi, algae
- Biofilm formation studies





WetLab-2
Automated RTqPCR



Bioculture System

FPA Research Applications

- Microorganisms
- Mammalian cells and tissues
- Viruses and bacteria
- Protein crystal growth
- Biomaterials
- Small plants/seed germination

https://science.nasa.gov/biological-physical/focus-areas/cell-molecular/hardware/

Spaceflight Hardware: Microbiology and Small Organisms

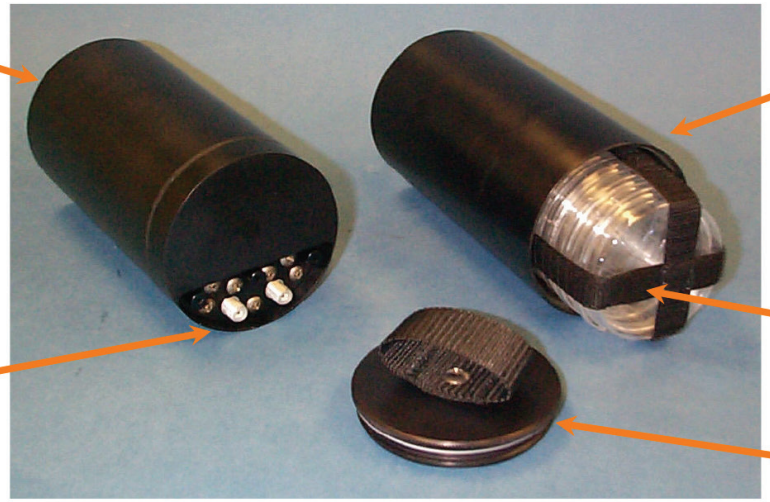


Fig. 1 BRIC-60 and BRIC-60M with petri dish configuration.

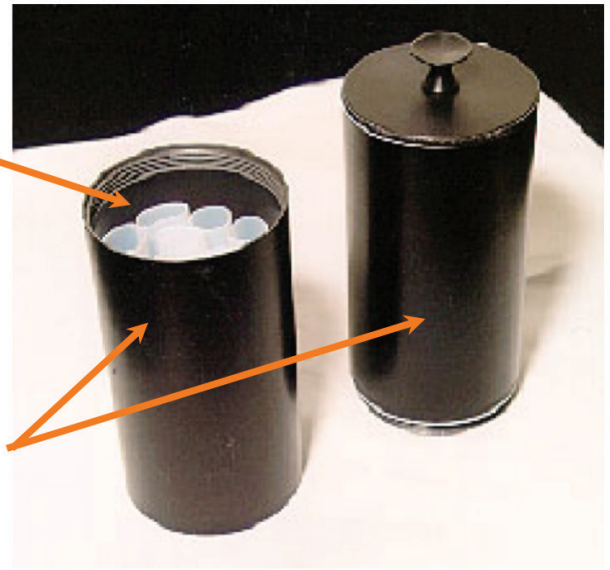
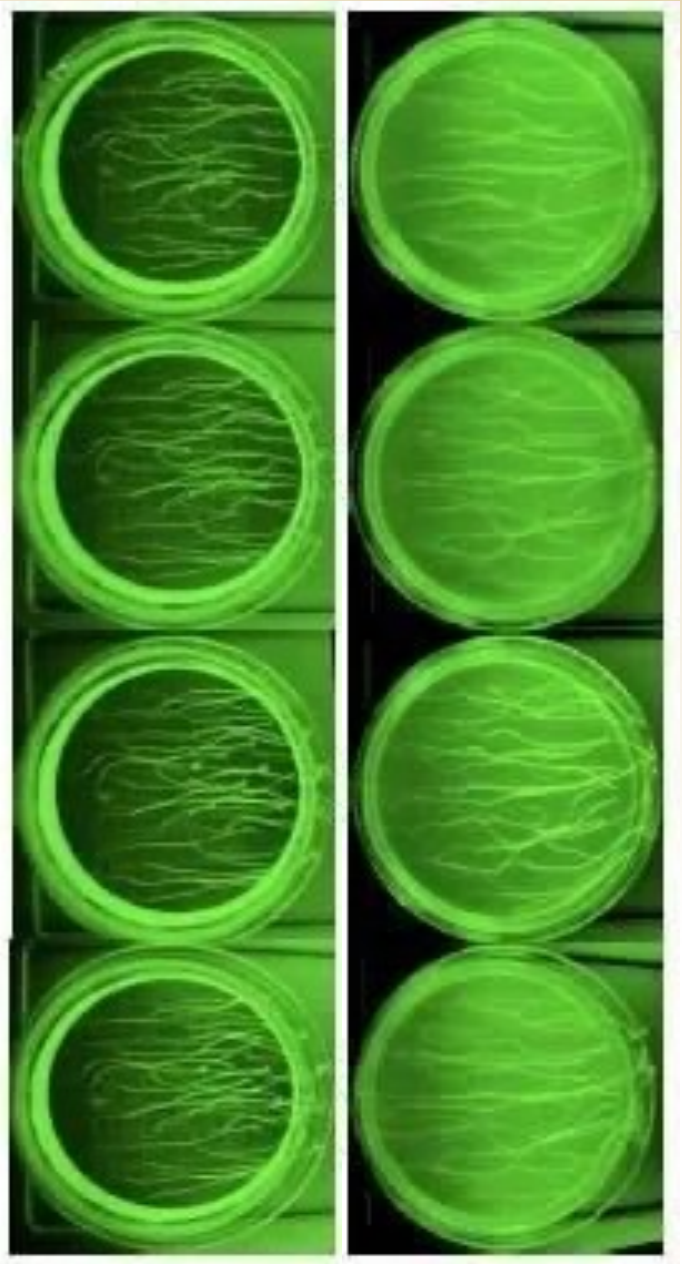


Fig. 2 BRIC-60 containing Teflon sample tubes.

Fig. 3 BRIC-60 Canisters as flown in an ISS stowage locker.

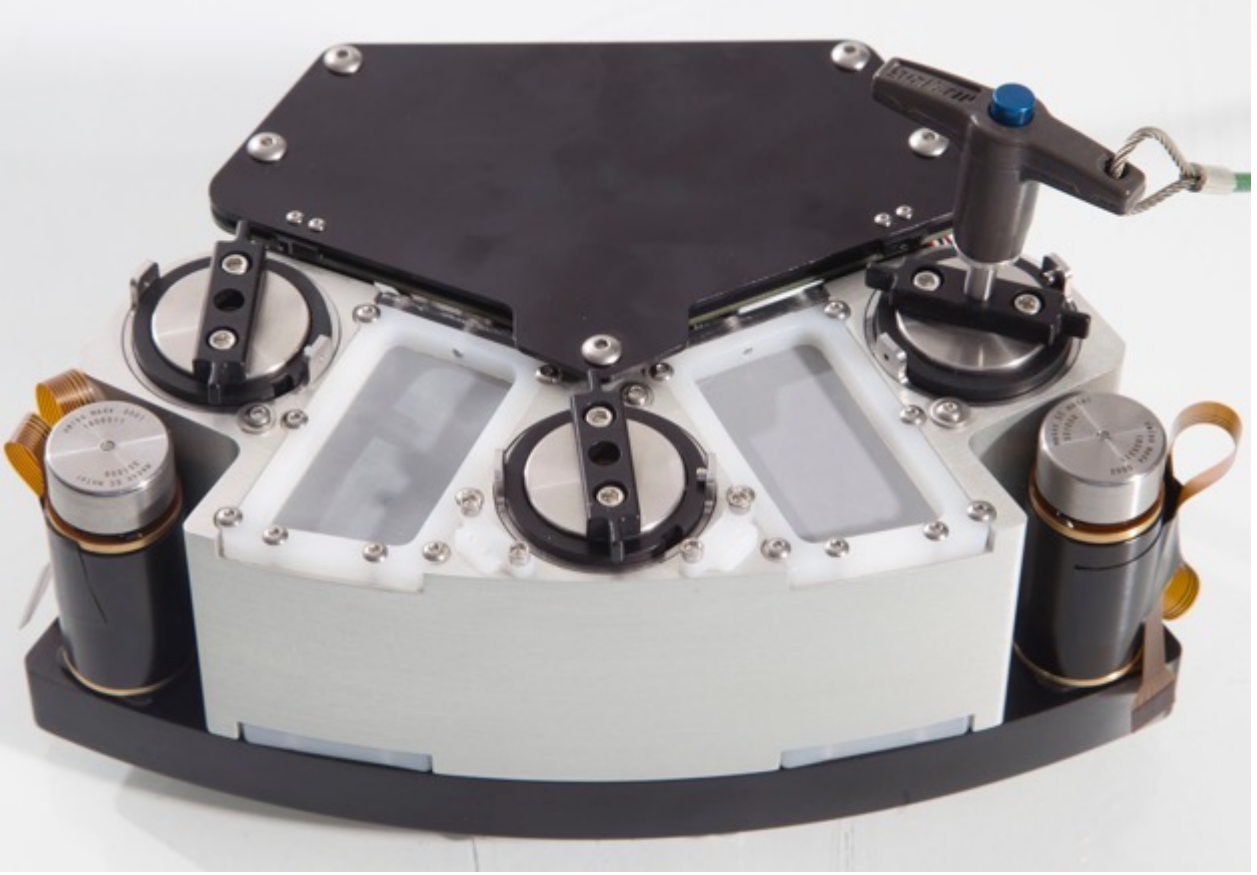


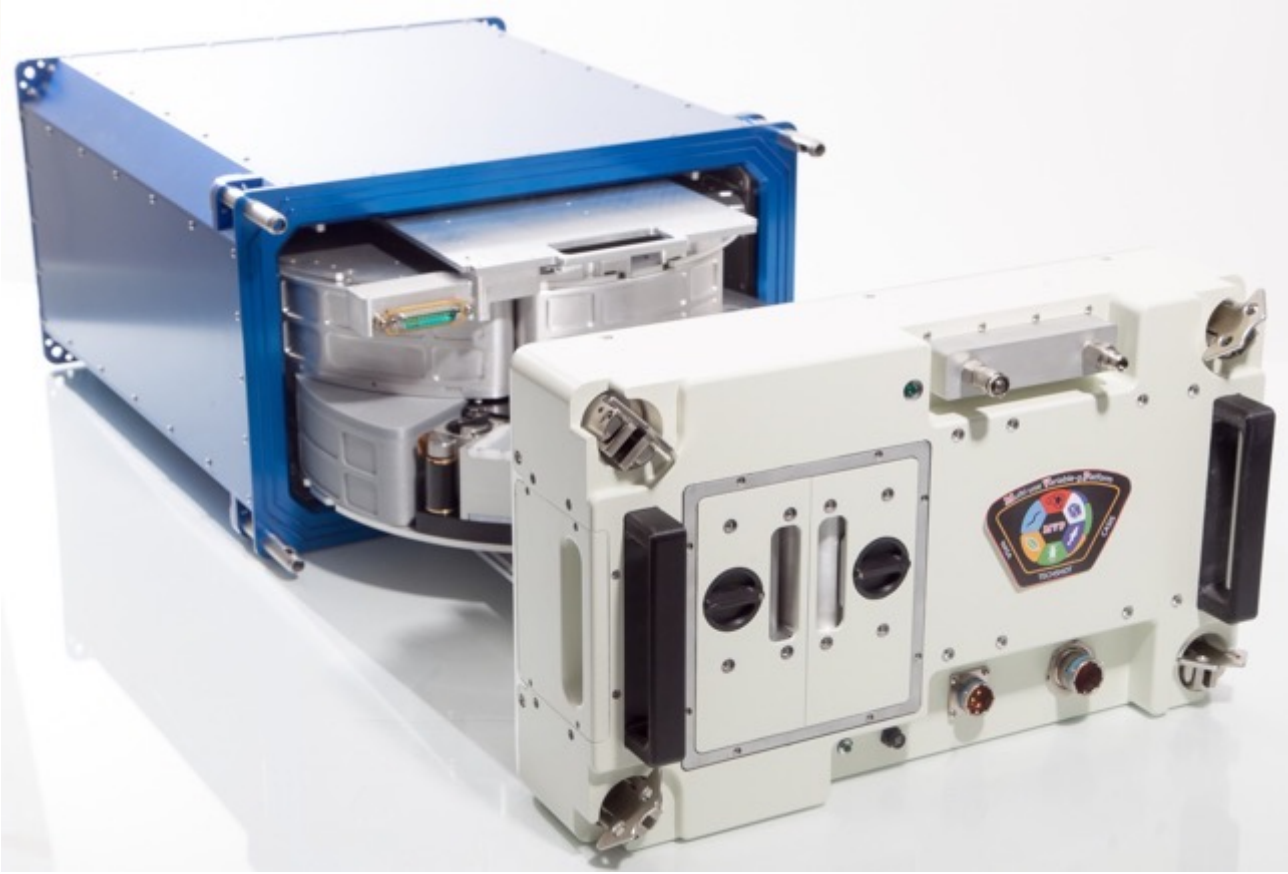
Biological Research in Canisters (BRIC)

https://science.nasa.gov/biological-physical/focus-areas/plant-biology/hardware/

Spaceflight Hardware: Small Animals

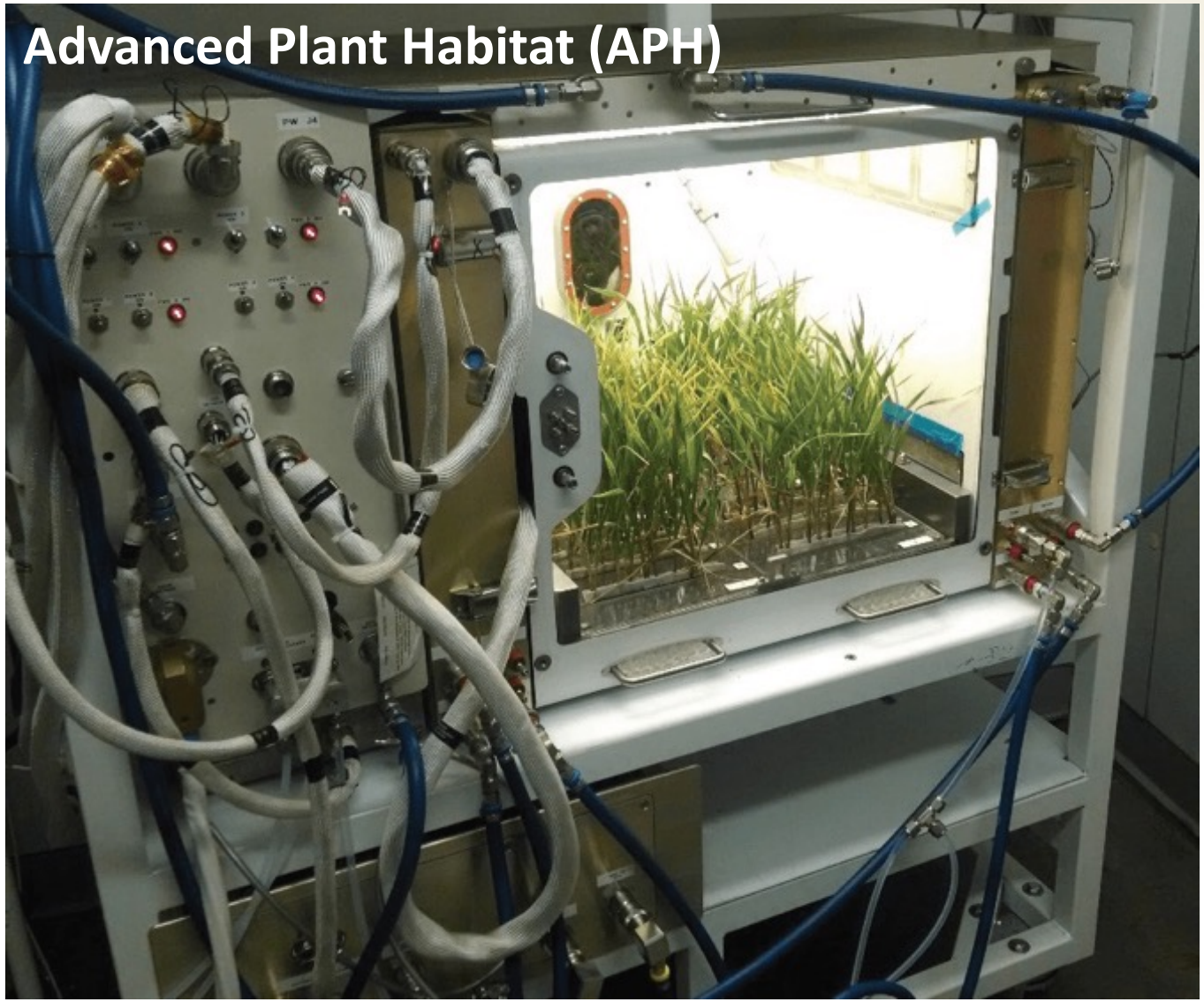
Multi-use Variable gravity Platform (MVP)





https://www.nasa.gov/ames/space-biosciences/multi-use-variable-gravity-platform-validation/

Spaceflight Hardware: Plants



Dwarf Wheat Growing in APH

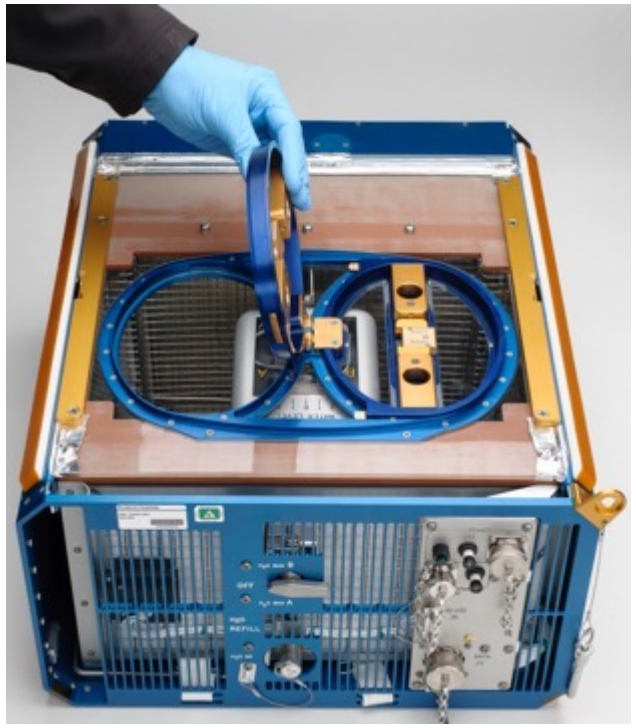
Astronaut Serena Auñón-Chancellor harvests red Russian kale and dragoon lettuce from Veggie on Nov. 28, 2018.

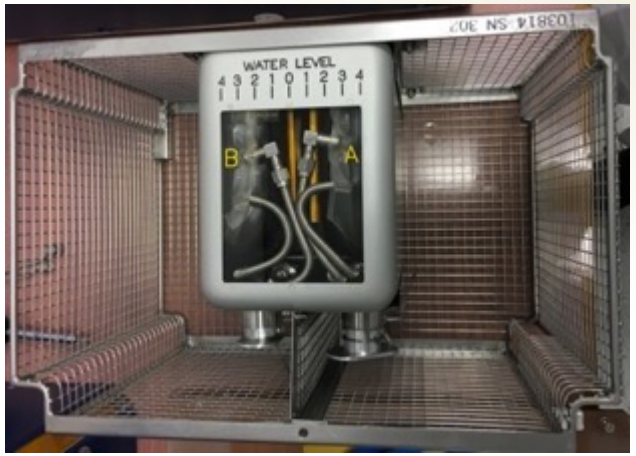
NASA astronaut Mike Hopkins has tended to multiple plant experiments on the International Space Station (ISS)

https://science.nasa.gov/biological-physical/focus-areas/plant-biology/hardware/

Spaceflight Hardware: Rodent Research

RR Habitat





Animal Access Unit (AAU)

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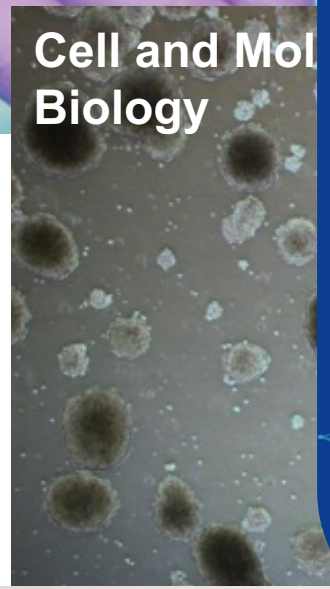
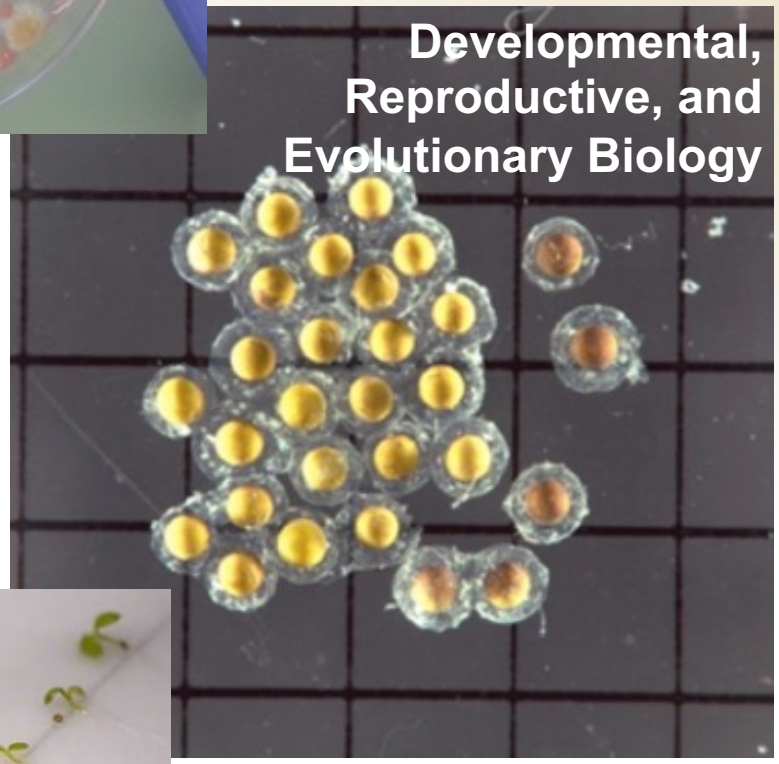
Spaceflight Hardware

https://www.nasa.gov/image-article/nasa-astronaut-jessica-meir-conducts-cardiac-research-2/

Space Biology Program



Open Science



https://science.nasa.gov/biological-physical/programs/space-biology

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Open Science Analysis Working Group Members

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END
GL4U: Introduction
Lecture 1 of 4